Supplement to THE ENGINEER

Northern Ireland and the Republic of Ireland

A Survey of the engineering industries of Ireland published on the occasion of the Summer visit of the Institution of Mechanical Engineers to Ireland, June 20 to June 24, 1960

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The " Mechanicals " in Ireland

Some years ago when the Institution of Mechanical Engineers took its members to the Netherlands for a summer meeting, we brought out a special supplement descriptive of the work of Dutch engineers. Again when the Institution last year took its members to Switzerland we published another supplement, this time descriptive of the work of Swiss engineers and entitled " Swiss Achievements ". We printed those supplements at those times and not in intervening years, when the summer meetings were held in England, Scotland or Wales, because we felt that engineers are likely to be less well informed about the work of engineers in foreign lands than about their work in this country, and would therefore welcome such supplements.

Why then, it may well be asked, bring out a supplement about Northern Ireland? Is it not part of Britain? Ought not engineers to be as well informed about it as about England, Scotland or Wales? The plain answer is that we do not believe they are; moreover some of the members will be visiting the Republic and we think the average British engineer is even less well informed about that country than he is about the nearer Continental nations. Thus, despite the fact that the greater part of this year's " Mechanicals " summer meeting is to be held in a part of Britain, we have still thought that such a supplement as this reviewing the work of engineers in Ireland, North and South of the border, would be welcome.

One of the facts which is certain to impress itself on the minds of the members during their stay in Belfast from June 20 to 23 is the degree of encouragement offered to industry to establish itself in Northern Ireland and the success of the policy of drawing a variety of industries to the area. The newly established works are second to none. Northern Ireland, in fact, is rapidly becoming one of the foremost industrial regions in Britain. In the Republic, however, conditions are different; it is still primarily an agricultural country. But it has certain distinctively interesting things to show visiting engineers. Above all and quite distinctive is the " harvesting " of peat as a fuel for power stations. One can, of course, hardly dare to mention Dublin, where some of the members will be staying on Friday, June 24, without also mentioning Guinness, which is both brewed and drunk there in vast quantities.

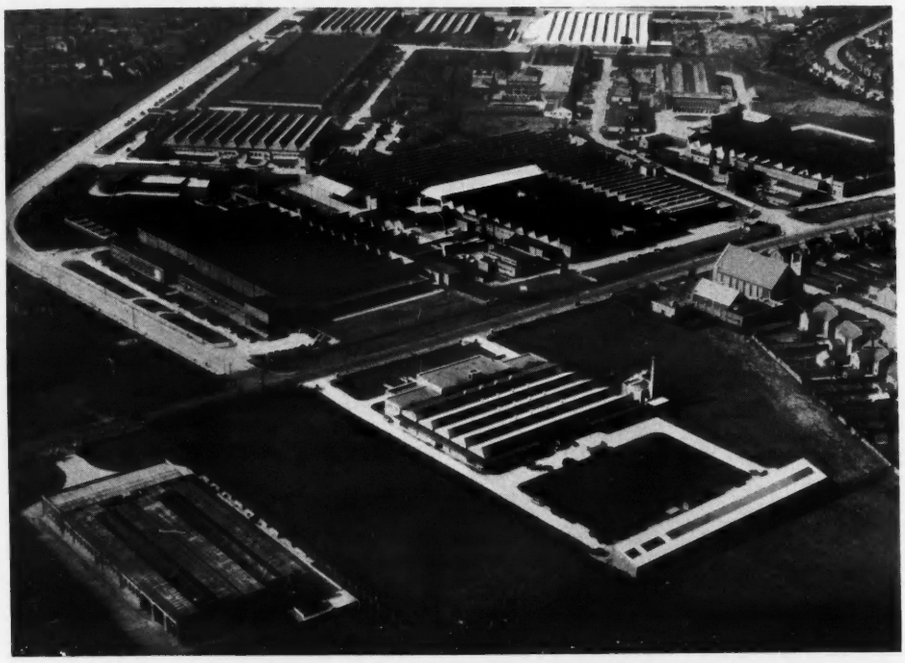
We feel very sure that the members and their ladies will thoroughly enjoy their visit. For both North and South of the border there is a charm about Irish people which can be matched nowhere else in the whole wide world.

Northern Ireland

IN the course of their visits to industrial centres in Northern Ireland the members of the Institution of Mechanical Engineers attending the summer meeting will have an opportunity to see some of the many new industries which have been established in recent years. They will note with interest the way in which many old-established and new firms in the United Kingdom and other countries have taken advantage of the facilities and incentives which are being offered to encourage the setting up of new factories. The Government of Northern Ireland has over the past fifteen years or so, given the utmost encouragement to companies contemplating the establishment of new works. This encouragement has taken the form of grants and loans towards the cost of works and equipment, factory space offered at low rental, cheap fuel and power and assistance in recruiting and training labour. Many new industrial estates have been set up and there is little doubt that the policy of the government in the industrialisation of what, up to less than two decades ago were, in many cases, preponderantly agricultural communities, is now having an increasingly beneficial effect on the economy of Northern Ireland.

Northern Ireland, an integral part of the United Kingdom and covering the great part of the old Province of Ulster, has a population approaching 1,500,000 of whom some 476,000 are insured for employment. Of this working population some 150,000 are employed in the engineering industry and this number is steadily increasing, whilst at the same time the amount of work available for the total of about 170,000 persons employed in linen and agriculture is decreasing. It is to counteract this decline in demand for labour in linen manufacture and agriculture that the Government is sparing no efforts and giving every encouragement to the establishment of new industries in the country in order to balance and diversify the economy. To promote and publicise the industrial facilities the Northern Ireland Development Council was set up in 1948 to work in conjunction with the Ministry of Commerce.

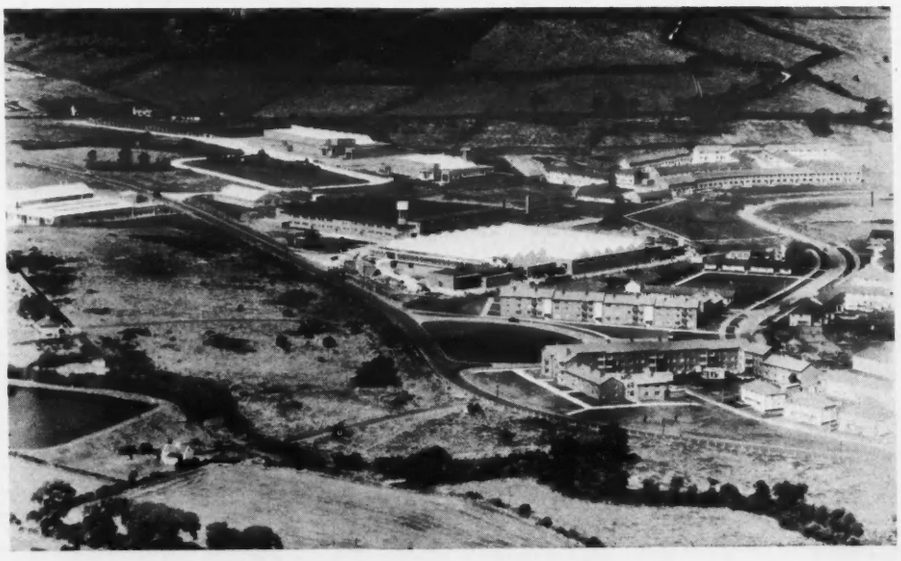
As a result of the progressive and realistic industrial development programme followed over the past fifteen years over 140 new firms, employing 26,000 people, have been established with Government financial and other forms of assistance, and some sixty works expansion schemes completed have provided employment for a further 12,000 hands. Factories of standard design made available to firms for renting or purchase on Government estates range from 2000 to 70,000 square feet of floor area and to date the factories built under the Government programme total some 4,500,000 square feet, whilst buildings totalling a further 1,500,000 square feet are now under construction or planned.



Castlereagh Government Factory Estate, Belfast

Within a few miles of Belfast, for many years a centre of the engineering and shipbuilding industry, no less than five industrial estates have been established—Broadway, Castlereagh, Carnmoney, Dunmurry and Monkstown. Broadway, the smallest of the estates, covers some 3 acres and to date four factories with a total area of 75,000 square feet have been built on it. The largest estate established under the development programme at Castlereagh on the southern outskirts of Belfast has an area of 90 acres and its general layout can be seen in one of the illustrations on this page. The ten firms established on this estate have factories covering a total area of 1,300,000 square feet, and employ some 4300 hands. Some of these works at Castlereagh have been included in the visits to be made by members of the Institution who will not fail to note the spacious modern layout of the estate and the high standard of factory architecture. Six factories have already been occupied by firms on the more recently developed 33 acre Carnmoney estate on the north shore of Belfast Lough, which is shown in another of the illustrations. Associated with this industrial project there is a large new housing estate and at the nearby Monkstown site plans are in hand for the construction of two works. Two of three factories completed at the new Dunmurry estate have been taken, whilst eight others are under construction or planned.

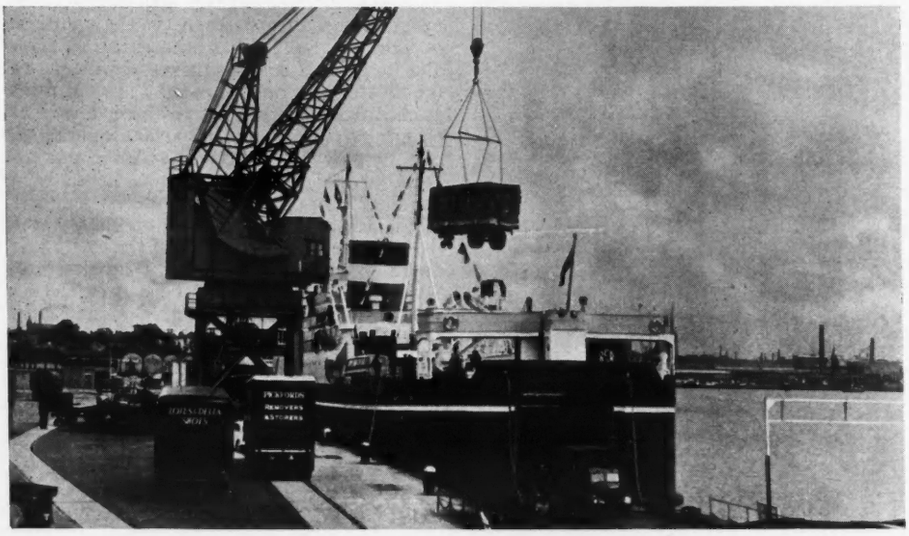
Larne in the north-east and Londonderry in the north-west of the country are also being extensively developed as industrial centres. Two important works at Larne are the turbine works of Associated Electrical Industries, Ltd., and the radio and television equipment factory of Corran Works, Ltd., a subsidiary of Pye, Ltd. Indicative of the encouragement given to new industries is the fact that for the A.E.I. and Corran works there has been built a large well equipped new technical school for training local people



Carnmoney Government Factory Estate, near Belfast

and for the advanced training of apprentices in conjunction with the firms' own schemes.

At the Maydown riverside industrial area near Londonderry two important new plants, one for Du Pont (U.K.), Ltd., and the other for Carbide Industries, Ltd., will shortly begin production and provide employment for some 600 men. Du Pont (U.K.), Ltd., has acquired a site of some 300 acres and is now starting production in a neoprene synthetic rubber plant, the first of its kind in the British Commonwealth. This plant will receive its acetylene supplies from the nearby works of Carbide Industries, Ltd. (a subsidiary of the British Oxygen Company, Ltd.). It is interesting to note that prior to the planning of these works it was proposed to build a new power station in Londonderry. To meet the requirements of the new works plans were revised and the power station has now been built at Maydown (Coolkeeragh) in a more convenient position to provide the new industries with power and steam. Furthermore, two jetties have been built at the mouth of the River Foyle to provide shipping facilities for the new factories and power station respectively.



Transport ferry ship being unloaded

Following the Government's plan to disperse industry as widely as possible and to encourage industries ancillary to agriculture, other factories covering a range of products from chocolate to shoes, food products to spectacle frames and chipboard to nylon stockings and textiles have been established on individually chosen sites in various parts of the country.

An important aspect in the growing industrialisation of the country has been the provision of efficient freight services and handling facilities at the ports. The works being carried out at Belfast Harbour are dealt with elsewhere, but mention must be made here of the freight handling facilities now available at Belfast, Londonderry, Larne and Coleraine for the transport of goods to Great Britain and other parts of the world. In addition to a container service there is a vehicle ferry service between Preston, in Lancashire, and Larne and Belfast for the transport of goods on lorries or trailers. Vehicles using this service are driven on and off the ships at the ports. One of our illustrations shows a transport ferry ship with vehicles being driven off along the quay ramp and trailers being unloaded by crane at the port.

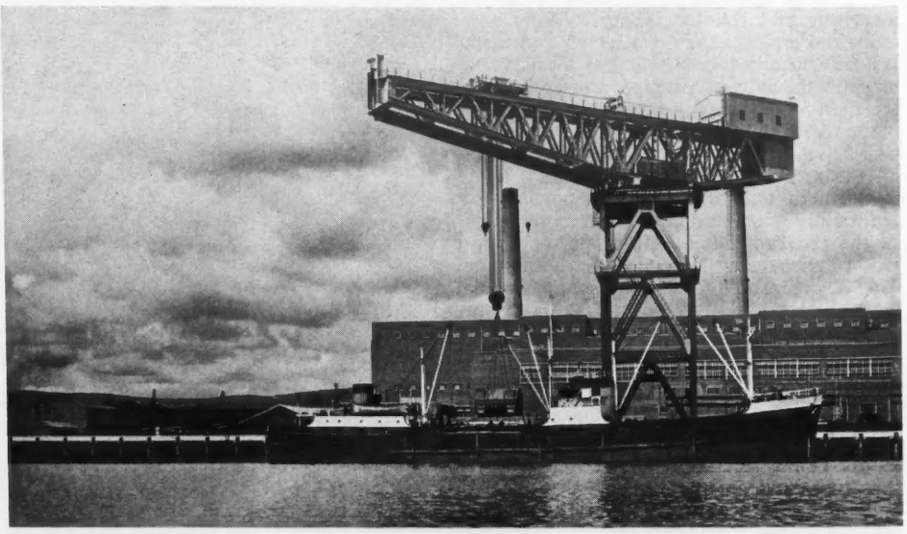
Belfast Harbour

A REMARKABLE concentration of industrial activity, all of direct interest to the engineer, can be seen during a visit to Belfast Harbour. First and foremost, the harbour itself is large and busy, exhibiting a variety of craft, and of quayside handling appliances and so on. Then there is a major programme of extension which is well on the way to completion. Within the harbour area, the shipyards form an impressive background with their towering cranes and the many ships in various stages of construction which can generally be seen. At the time of the Institution's visit, the fitting out of the liner " Canberra " will be well advanced and her great bulk and light alloy superstructure will be very prominent. Apart from the yards and the works of Harland and Wolff, Ltd., the aircraft works of Short Brothers and Harland is also within the dock area, and there is also the harbour airport, which is used by the latter firm and also by the Admiralty. Yet another activity is power generation, and two of the four principal power stations of Northern Ireland are situated in the harbour area. The harbour is well shown by our frontispiece. The River Lagan swings from the right of this illustration, down the centre. Immediately downstream from the bridge (Queen's Bridge), Donegall Quay on the left handles daily cross-Channel passenger and freight services. Beyond Donegall quay, the straight channel, extending right out into Belfast Lough, is known as Victoria channel. The two other principal " arms " of the port, namely the Herdman channel and the Musgrave channel can be seen to the left and the right of Victoria channel respectively.

The Belfast Harbour Commissioners have in progress a £5,000,000 programme of development, which is now about 75 per cent complete. All the various new works have been constructed under the direction of the Commissioners' chief engineer, principally by contract, but also by a direct labour force. The principal works in the programme are (i) deepening and widening Victoria channel ; (ii) reconstructing Albert quay, a quay 1482ft long serving the coal trade, which is on the left-hand side of Victoria channel in the aerial view, just beyond Donegall quay, to which we have already referred ; (iii) the new Stormont wharf, with a shed and 200-ton crane, again on the left of Victoria channel in the aerial view, beside the power station ; (iv) the Sinclair wharf and shed, to be seen on the opposite side of the power station, i.e. on the right-hand side of Herdman channel, and (v) new berths on the west (i.e. left-hand) side of Herdman channel, approximately opposite Sinclair wharf.

Victoria channel extends about 25,000ft beyond the harbour entrance to the sea, as a navigation channel marked by beacons and buoys. It has been widened by 100ft, and its turning basin immediately outside the port enlarged to 1400ft in diameter. A depth of 36ft 6in is now available at high water in this channel. Two extensive areas have been reclaimed with the spoil from dredging. In the aerial view these areas can be clearly seen ; the one to the left of the harbour mouth is about 50 acres in extent and is soon to be partly occupied industrially. The larger area in the right background has, since the photograph was taken, been extended beyond the limits shown.

The reconstruction at Albert quay involves the installation of new level-luffing 5-ton

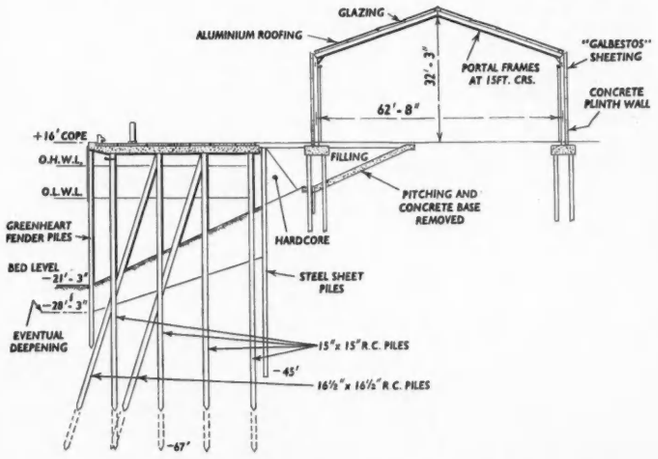


200-ton cantilever crane, Stormont Wharf, Belfast harbour. Belfast Corporation's West power station is in the background

cranes, and deepening to give 20ft depth at ordinary low water.

Stormont wharf and its 200-ton crane are shown in the accompanying illustration. The wharf is about 650ft in length, and, like the other new wharves, has 30ft depth of water alongside at ordinary low water, with provision for deepening to 35ft. The crane lifts 200 tons at 95ft radius at a hoisting speed of 5ft per minute its cantilever arm being 140ft long, and the overall height of the crane 167ft. It is equipped with two auxiliary hooks, which can lift 25 tons and 5 tons respectively, at rates of 24ft and 80ft per minute. The crane was installed initially for lifting large pieces of generating plant exported from the A.E.I. factory at Larne. It also provides one of the facilities which will help to encourage industry to settle in Northern Ireland and thus, like certain other of the development works in the port, has been built with the help of Government grants.

Sinclair wharf and shed on the East side of Herdman channel were opened in 1958. The wharf is 1241ft in length and is supported by reinforced concrete and steel box piles, the filling behind the wharf being retained by a steel-sheet-pile facework connected by tie-rods to concrete anchorages. The superstructure is of flat soffit reinforced concrete, 2ft thick, with a 6in wearing course on top. The wharf was constructed " in the dry " and



Cross section of new Wharf at Herdman Channel. Raking piles take the side thrust from the steel sheet piles, but in other situations the steel sheet piles are tied and anchored

the berth subsequently dredged. The shed is 1100ft in length, and 120ft in width. It is carried on piled foundations and has " N " braced roof trusses, giving a clear span of 120ft and a clearance of 29ft 9in over its full width; it accommodates approximately 15,000 tons of bagged goods or 10,000 tons of general cargo.

A typical cross section of the new wharfage on the west side of Herdman channel is shown in the drawing. A general similarity to Sinclair wharf is apparent, and, indeed, this type of construction is becoming typical of the port. The wharf recently completed here is about 1200ft long, and is for cross-Channel freight services. It is intended particularly for " container " traffic and is equipped with up-to-date cargo handling facilities.

There is a proposal to build a further wharf on the west side of Herdman channel. Since an appreciable proportion of the cost of all the new works in the port is due to piled foundations (generally estuarine silt up to a depth of some 30ft overlies harder clay, to which piles are driven) advantage has been taken of this site to carry out piling tests. The Building Research Station has undertaken studies of test piles here, using an approach based on loading the pile at a constant rate of penetration until the maximum load, defined as the " ultimate " load, is reached. Interest in the same problem is apparent in the design of some storage tanks, where soil studies indicated that if the tanks were built on a 4ft thick base of granular fill, stability would be achieved after an initial settlement of about 1ft.

Another example of the variety of engineering problems encountered in the harbour may, perhaps, be briefly mentioned. Recently, the raked stem of a vessel collided with a dockside shed, at about the level of the eaves, and pushed the eaves sideways 2ft or 3ft. Instead of demolishing the shed, a method was devised for jacking it back to its original position, and a successful repair was completed.

Turning to a matter of direct interest to mechanical engineers, we find that the steam-engine-driven centrifugal pumps serving the two main graving docks — Thompson and Alexandra docks — are now to be replaced, after fifty years use, by modern electrically powered plant. The hydraulic system operating the sluices, &c., is supplied by an accumulator, replenished by steam-driven pumps; two-cylinder compound steam engines are employed, with a double-acting pump concentric with each cylinder of the engine, and directly driven from each piston rod, which is divided, and passes on each side of the pump.

Transport

THE public transport system in Northern Ireland, excluding the Belfast Corporation Passenger Transport Services and certain freight carriers in Belfast and Londonderry, is now controlled by the Ulster Transport Authority which, when it was set up in 1948, was given the task of merging three separate undertakings—the former Northern Ireland Road Transport Board, the Belfast and County Down Railway, and the L.M.S. (Northern Counties Committee). In 1958 there was also merged the Northern Ireland portion of the Great Northern Railway. The Authority has been responsible for organising and integrating the system of public transport for passengers and goods by rail and road in Northern Ireland. It does not, however, have a monopoly of road freight traffic—as firms and individuals can, and do, carry their own goods in their own vehicles, but they are not permitted to transport goods for hire or reward with certain minor exceptions.

As has been the case in most other countries, the railway services in Northern Ireland run at a heavy loss as a result of the decline in rail traffic and increasing costs in maintenance and working. For this reason the Authority has carried out a policy of closing unremunerative lines for some years and, as a result, all the narrow gauge lines, and some other sections, have been shut down and their services replaced by road transport. The 296 route miles of railways now in operation are all of the standard 5ft 3in Irish gauge. In recent years a total of some 300 route miles have been closed. In this overall scheme of reducing costs, a large number of small stations and halts have been closed and a road transport service introduced. The remaining railway services are mainly used for passenger transport as the biggest quantity of goods traffic is carried by road vehicles ; where fast rail handling of goods is required the general practice is to couple the wagons to trains in normal passenger service. In this work of nationalising and integrating its passenger and goods transport system the U.T.A. is in an advantageous position for, although it has frequently to meet local opposition, it has a true measure of current transport

U.T.A. four-coach multi-purpose diesel train on Larne line

usage upon which to base its decisions in providing adequate new facilities to meet local requirements.

Diesel traction is being used to an increasing extent on the railways and the proportion of train mileage worked by diesel traction increased from about 10 per cent in 1951 to nearly 70 per cent in 1959. There are now some eighty-three diesel railcars and seventy railcar trailers in service and practically all of this stock has been designed and built at the Authority's main workshops in Belfast. Just over two years ago there was introduced into the service by the Authority a new series of railcars designed to run in trains of up to ten vehicles, eight of which may be powered cars. One of the trains can be seen in our illustration. These vehicles are fitted with through heating, utilising hot water maintained at a predetermined temperature by thermostatic control, the heat being obtained from an exchanger utilising the exhaust gases of each vehicle, the whole heating system being further controlled by a "room stat," in order to provide a constant train temperature in either powered or trailing coaches irrespective of the number of engines in service within the train.

In accordance with the usage for which these railcars were designed, the Authority has termed them "multi-purpose" diesel trains. The power cars are fitted with compressed air brakes, and air is also used for the operation of the throttle and the gearboxes, but automatic vacuum equipment is also installed in the cars to enable them to haul vacuum-fitted stock either passenger-carrying or parcels vans.

The powered vehicles are fitted with a prototype Leyland power unit turbo-charged to develop 275 b.h.p. Service miles have established an improvement in the order of 25 per cent on fuel consumption compared with the orthodox aspirated units developing the equivalent horsepower per vehicle. In the power transmission system a twin-axle bogie is driven through a single-stage torque converter, a bi-directional gearbox, and an automatically-controlled four-speed planetary gearbox. This combination was introduced to give approximately 90 per cent efficiency throughout the operating range at virtually constant engine speed and at constant rail horsepower at all car speeds. The use of fully automatic gearbox control makes it possible for only full engine efficiency to be utilised without any action on the part of the driver. This development provides a means of railway traction capable of speeds on passenger work of up to 90 m.p.h., together with the ability to haul heavy tail loads. These units are at present hauling loose-coupled freight stock, the maximum limitation being 100 tons per powered car.

Fitting end of main workshop for road and rail vehicle construction, maintenance and repair

The new cars were introduced on the Belfast–Coleraine–Londonderry service, a distance of about 93 miles, of which two-thirds is single line, with a scheduled time of 110 minutes including five stops. One of the trains can be seen in our illustration, and it is possible that the visitors will be able to inspect one of the power cars in the Belfast works. A detailed description of one of the first of the railcars to be put into service was given in THE ENGINEER of January 24, 1958.

Turning to the road transport side of the Authority's activities, it operates nearly a thousand touring coaches and buses for its passenger services and the vehicles engaged in road haulage of goods include nearly 1000 lorries and vans, and about 1000 trailers with 178 containers. During 1959 passenger omnibuses covered some 28,633,000 miles, and goods vehicles nearly 13,500,000 miles in service. Most of the vehicles and buses now in service have bodies designed and built in the U.T.A. workshops to its own specification and requirements. For some time the Authority has encouraged traders to specify vehicle requirements for their particular classes of goods and the Authority then undertakes to build, maintain and run the required services with such special vehicles on a contract basis with the user. In this way a manufacturer or distributor can be relieved of all the problems of vehicle running, maintenance and garaging, which are undertaken by the Authority with its specialised experience and facilities. These vehicles come under the standard planned maintenance schedule laid down for the public service vehicles, which undergo at specified mileages intermediate inspections and minor overhauls with a complete major overhaul after every 250,000 miles in service.

Main workshop of Ulster Transport Authority in Belfast

The main road-rail mechanical workshops of the Ulster Transport Authority in Belfast is included in the series of visits to be made by members, and is of interest because of the unusual combination of work in progress in the one establishment. This work includes the complete overhaul of road and rail vehicles and their power units, running repair work, body building for road and rail passenger vehicles, special goods vehicle body construction, vehicle painting and cleaning, and driver-training on a ground which includes a skid path. The general design of the main workshop building, covering over 190,000 square feet, can be seen from the aerial view we reproduce, and part of its lay-out is shown in the photograph taken from one corner of the machine bay.

The general practice followed when road or rail vehicles come into the shop for overhaul is to strip out and clean engines, axles and transmissions and deliver them to the fitting section to be seen on the left of the machine bay in the illustration. As the units are stripped, their components are inspected and parts such as crankshafts, cylinders, brake drums, &c., which can be reconditioned by machining are passed into the machine lines, whilst parts in usable condition are returned to stores and worn out parts scrapped. In rebuilding the units new and reconditioned parts are batched and returned

to the assembly benches. A system of standard replacement and reconditioning sizes is followed and no attempt is made to reassemble an engine with its original components. Ancillary shops are equipped for diesel pumps and injector overhaul, and electrical unit repairs.

Beyond the fitting shop lines are sections devoted to the repair, overhaul and building of passenger and goods vehicle bodies, whilst in a partitioned section at the far side of the building is the carriage and wagon shop. A series of rail spurs down the length of this shop are used for building and overhauling rail vehicles, which are delivered to the spurs from sidings by a traverser running along the width of the shops outside the building. Near the main workshop there is a large maintenance shop for the local Belfast road vehicles, a diesel railcar running shop, a vehicle washing plant and a steam locomotive running shed.

The volume of work carried out in the works is indicated by the fact that last year it was responsible for the overhaul of fifty and the building of thirty new rail carriages, wagons and railcars ; and the overhaul of some 1400 buses and trailer vehicles and the building of nearly a hundred road vehicles.

Electricity Supply

There are three separate electricity authorities in Northern Ireland, who, between them, sold 1152 million units in 1957, and had an installed capacity of 505MW. The Belfast Corporation Electricity Department is responsible for the area within the city boundary and a contiguous area of approximately equal extent, in all, approximately 83 square miles ; the Londonderry Corporation Electricity Department for the area within the Londonderry City Boundary, approximately 3½ square miles ; and the Electricity Board for Northern Ireland for the remaining area in Northern Ireland of approximately 5200 square miles. All the power stations are listed in the table.

Belfast Corporation's stations are both coal-fired, deliveries of coal being by sea direct to jetties alongside the site with coal handling facilities to transport coal direct from the hold of the boat to the boiler bunkers or coalfields and thence to bunkers. Boiler plants in both cases are chain grate stoker fired.

The boiler plant at Ballylumford and Curran Point (the latter is now used only during occasional peak load periods) is chain grate stoker fired and in the case of Ballylumford, coal supplies are delivered direct by sea to the station jetty with coal handling facilities to transport coal direct from the hold of the boat to boiler bunkers or to the coalfield and thence to the bunkers.

At Coolkeeragh supplies of oil are delivered direct by sea-going tankers to the jetty adjacent to the station and pumped to the main storage tanks and thence to the " ready use " tanks.

The generating stations of the Belfast Corporation and the Board have, over the years, been run conjointly and in addition the Board has purchased limited supplies from Londonderry for distribution in a relatively small part of its north-western area. A joint Electricity Committee was established in accordance with the provisions of the Electricity (Supply) Act (Northern Ireland), 1948.

The major generating stations are interconnected with the Boards 110kV grid, from which supplies are transformed to feed into the 33kV transmission system.

The Coolkeeragh site not only is convenient as an additional supply to Londonderry but also lends itself readily to the supply of electricity and steam and other facilities (cooling water and demineralised water) to the large industrial projects of Du Pont Company (United Kingdom), Ltd., and of supplies of electricity to Carbide Industries, Ltd. at Maydown close by. The additional freight charges on coal to Londonderry compared with those for the other major generating stations in Northern Ireland and the relatively favourable all-in cost of oil determined the choice of oil-firing in preference to coal.

Coolkeeragh is the first station in Northern Ireland in which oil-fired unit boilers have been installed. It will make a substantial contribution to supplies of electricity in Northern Ireland as a whole and will ensure the technical and economic advantages of a source of generation near to the load centres of the north-eastern and western sections of the Board's area of supply. The site is capable of development up to 420MW.

Power Stations in Northern Ireland

	Turbo generators	Boilers
Belfast Corporation's Municipal Power Station West	2 × 30MW	4 × 180 k.lb per hour at 925 deg. Fah. and 650 lb per square inch.
	3 × 60MW	9 × 220 k.lb per hour at 925 deg. Fah. and 950 per square inch.
Belfast Corporation's Municipal Power Station East	1 × 6MW 2 × 15MW 1 × 18·75MW	6 × 60 k.lb per hour and 2 × 80 k.lb per hour at 700 deg. Fah. and 250 lb per square inch.
	2 × 30MW	4 × 150 k.lb per hour at 780 deg. Fah. and 250 lb per square inch.
	2 × 30MW	6 × 150 k.lb per hour at 850 deg. Fah. and 650 lb per square inch.
Londonderry Corporation's Strand Road Station	1 × 1·5, 1 × 3·75 2 × 6MW	2 × 10 k.lb per hour, 2 × 20 k.lb per hour and 2 × 60 k.lb per hour, all at 750 deg. Fah. and 225 lb per square inch.
Electricity Board for Northern Ireland's Stations : Ballylumford	1 × 30MW	2 × 150 k.lb per hour at 800 deg. Fah. and 240 lb per square inch.
	3 × 31·5MW	7 × 150 k.lb per hour at 835 deg. Fah. and 625 lb per square inch.
Curran Point, Larne	2 × 6MW	3 × 50 k.lb per hour at 680 deg. Fah. and 250 lb per square inch.
Coolkeeragh (oil-fired)	2 × 30MW	2 × 380 k.lb per hour at 870 deg. Fah. and 625 lb per square inch.
Coolkeeragh : under construction	1 × 60MW	1 × 550 k.lb per hour at 935 deg. Fah. and 950 lb per square inch.

Note : See map on page 2 for power station sites.

Engineering Studies at Queen's University

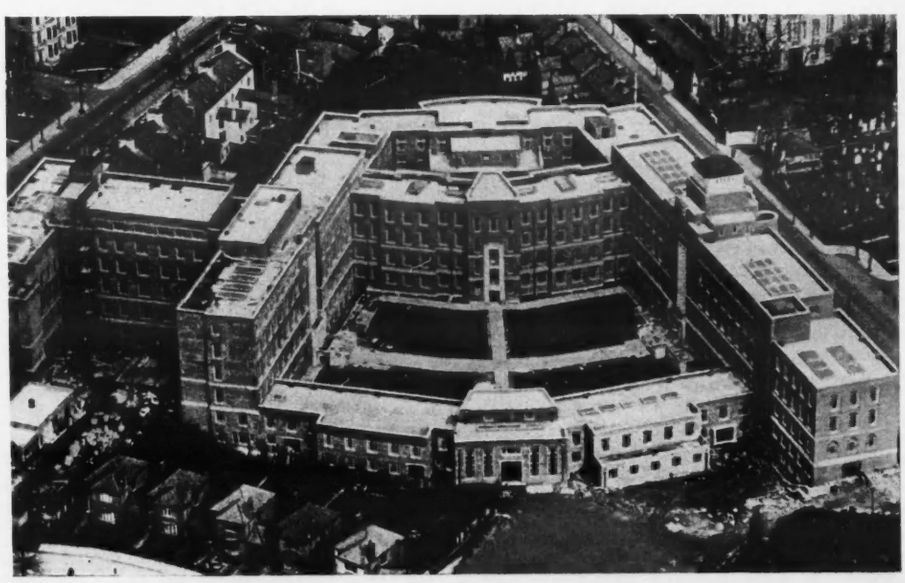
The David Keir Building of Queen's University, which is to be visited, was opened by the Duke of Edinburgh in May, 1959, and it provides accommodation for the civil and aeronautical engineering, chemistry, botany, zoology, and biology departments as well as temporary accommodation for the heavy electrical engineering department. The engineering departments in the building include the laboratories for structures, strength of materials, concrete, hydraulics, soil mechanics aerodynamics and electrical work. A new eleven-storey building with a floor area of some 150,000 square feet being built adjacent to the Keir building will provide much needed accommodation for the mechanical engineering department, which is based in the College of Technology. A two-storey block due for completion in 1963 will house the laboratories of the mechanical engineering and some heavy electrical engineering departments.

The chair of civil engineering, is held by Professor A. H. Naylor and the chairs of mechanical engineering, heavy electrical and light electrical engineering, and aeronautics by Professors B. Crossland, J. C. West, T. P. Allen and A. V. Stephens, respectively.

The research activities at present in hand in the mechanical engineering department include investigations into cumulative fatigue damage and wave action in ducts connecting oil engines to exhaust turbines. Research is being initiated into problems associated with extremely high fluid pressures of 200,000lb per square inch, and into the optimum design of compound engines.

In civil engineering, research is being carried out into the lateral stability of bow-string arches. In soil mechanics the behaviour of groups of piles in sandy ground is being studied, both in the laboratory and in the field. Hydraulic researches include investigations into the stability of radial flow.

In the electrical engineering department, research is proceeding along three main lines; development of automatic control systems, construction of special purpose high-speed analogue computers, and research on high voltage insulation. In the aeronautical department much effort has been devoted to the design and development of a man-powered aircraft under the direction of Mr. T. R. F. Nonweiler.



The David Keir building, Queen's University, Belfast

Associated Electrical Industries Ltd.

THE turbine-generator works (Right) of Associated Electrical Industries, Ltd., was established at Larne some six years ago by the former British Thomson Houston Company, Ltd., to supplement the productive capacity of that firm's main turbo-generator shops at Rugby. It is set out on a 70-acre site and comprises two main factory buildings, one equipped for the manufacture of turbine generators and the other for the production of all the turbine blades required in this and the Rugby works. Larne was chosen for the site of the new works as there was an adequate supply of labour available in the area, excellent port facilities and assistance by the Government of Northern Ireland in starting new projects.

As the visitors will see, this co-operation between the authorities and the firm has resulted in the establishment of what must be one of the largest and best equipped works of its kind in Europe. Typical of the assistance given by the authorities were the provisions made to facilitate transport of heavy equipment made in the works. A new 650ft long quay was built by the Belfast Harbour Commissioners and equipped with a 200 tons capacity crane for loading the heavy turbine and generator parts on to ships. A 22 miles long road between the works and the harbour was widened and straightened and the Ulster Transport Authority purchased a 200-ton road transporter capable of carrying the largest parts directly to the new quay.

Further improvement works carried out at Larne harbour, some 2 miles from the factory, enabled the use of a " drive-on " – " drive-off " service of ships to take vehicles with loads up to 45 tons directly to England without need for transfer at ports.

The training of staff was undertaken with Government financial aid by a skilled nucleus of instructors supplied by the firm and 95 per cent of the 1400 hands now employed were trained on the premises. For some years now an apprentice training scheme has been in progress and this scheme is now supplemented by that given at a recently completed technical school in the town.

The new factory, some views of which we reproduce, is a completely self-contained manufacturing organisation with its own design departments, drawing-offices and auxiliary services, including a power station and gas-producing plant. Although at present the largest turbine generator sets built are up to 120MW, the capacity of the plant installed is designed to enable the manufacture of the largest machines likely to be required in the foreseeable future.

As can be seen from our aerial view, the works is situated in particularly attractive surroundings. To the seaward side of the two main factory buildings there is a large office block and a canteen. The smaller nine bay building, of some 70,000 square feet floor area, incorporates the turbine blade manufacturing shops, a tool room, cutter grinding section, and a standards laboratory. This blade making shop has been in production for about five years and is equipped with the latest types of profile milling machines and other plant for making blades in the complicated shapes now called for in modern design.

The main turbine factory, with a productive floor area of some 400,000 square feet, is made up of two " high " bays, each 850ft long, and 100ft wide, connected by two 30ft high, 60ft wide bays and flanked on one side by two 50ft wide bays, and on the other by a single 25ft wide bay. A 50ft wide bay running along the full width of the building at one end of these parallel bays provides a materials store feeding directly into the heads of the production lines. One of the high bays is devoted to the manufacture and testing of steam turbines and the other to heavy plate fabrication and generator stator manufacture. The two central bays connecting the high bays are equipped with medium and light machine tools for the production of the lighter components, which are fed sideways out to the main assembly areas and a turbine rotor blading station.

The turbine bay has a height of 74ft to the underside of the roof truss and its full length is served by two sets of overhead cranes. One set of these cranes, of 75 tons capacity, is carried on gantry rails 63ft above floor level and another two, of 30 tons capacity, run on rails 43ft above the floor. In keeping with modern practice the bay is laid out for flow production, starting with heavy machining operations at one end and moving the components progressively through the machining stages towards the far end of the shop where the erection and test beds are situated.

The steel castings for turbine casings are supplied to the works from outside sources, but the heavy fabricated casings being used to an increasing extent are made in the plate welding department at the top end of the other high bay. Is is standard practice in these works to shot blast all heavy castings and fabrications before they are delivered to the machine lines, and for this purpose a blasting chamber taking work up to 22ft by 38ft by 18ft has been installed. The first operation of milling the joint faces on the turbine casings is carried out on the Kendall and Gent plano miller, to be seen on the left in the illustration below. This machine, which takes work up to 8ft 6in high under the cutters, 14ft 6in between the uprights, and has a 32ft long table, can also be used for drilling and tapping the necessary joint holes in the casings. The advantage of modern machining methods is shown at this particular stage in the accuracy and high finish achieved on the casing faces, which eliminates need for subsequent hand finishing.

Another noteworthy machine in this production line is an Asquith 10in spindle ram-type horizontal milling and boring machine, which was the first machine of its capacity and size to be built. This machine, with its longitudinal column travel of 20ft and vertical saddle traverse of 15ft, combined with the

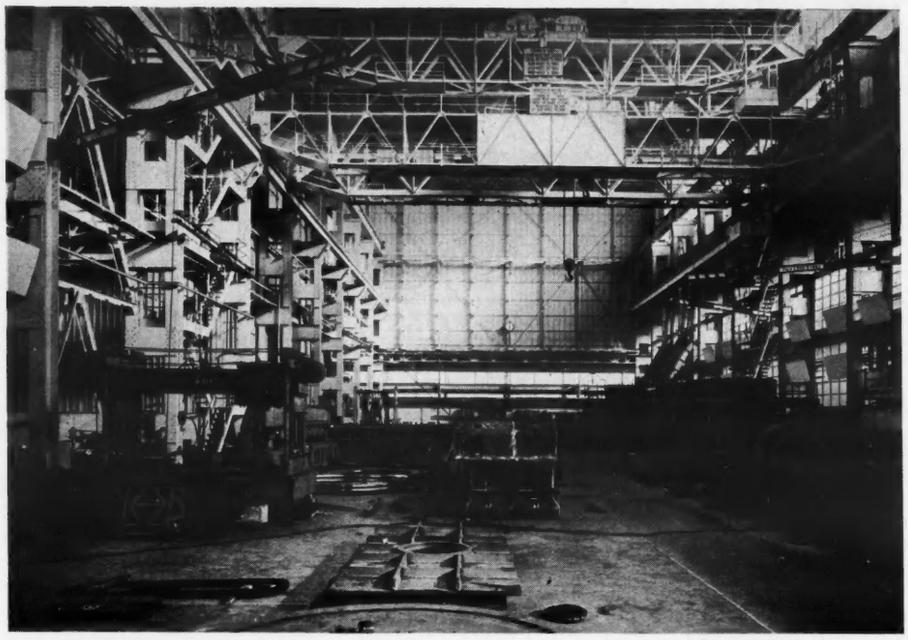
Heavy machining end of main turbine building " high " bay

spindle and ram travel totalling 11ft 6in, can complete an extensive succession of operations at one setting of the workpiece on its rotatable table. For the turning of rotors and shafts the range of lathes available extends up to a Craven machine swinging work up to 5ft 8in over the saddles and between 28ft centres, whilst for finish machining bladed low-pressure rotors a light duty Noble and Lund lathe, swinging work 16ft 4in over the bed between 25ft centres, has been installed.

After machining the turbine casings undergo a hydraulic pressure test in an intermediate section of the floor, which is also equipped for testing the rotor assemblies delivered into the main shop from the building section in one of the side bays. The turbines are assembled on a test bed over a 200ft long trench along which there runs a 6in steam main from the boiler-house and a 6in exhaust main leading out to a condensing installation capable of handling 55,000lb of steam an hour. At four points along the live steam main 6in branches are inserted for coupling to the turbines. Our illustration below shows the intermediate pressure and low pressure casings of a 120MW turbine being assembled. At the rear of the bed there are two wall-rail mounted 1-ton jib cranes for handling the lighter components during assembly.

A separate power house adjacent to the assembly end of the turbine shop has two Babcock and Wilcox oil-fired, water-tube boilers, each with a capacity of 60,000lb of steam per hour at 420lb per square inch and 765 deg. Fah. One of these boilers supplies steam for turbine testing and the other for process steam and driving a turbo-generator which supplies part of the factory power requirements. Back-pressure steam from this set is used for factory heating in the winter, and in summer, when no heating is required, the turbo-generator is shut down and process steam supplied by a Danks economic boiler.

The high bay concerned with heavy plate fabrication and alternator stator building is also equipped with dual sets of overhead cranes of 75 and 200 tons capacity, the 200-ton crane being capable of handling the largest size of stator and rotor built. The cutting, forming and other preparation of plates for the fabrication section at the top end of the shop is carried out in an adjoining low bay. The main fabrication area where the large turbine and stator casings are built up adjoins an annealing furnace, the bogie of which can be traversed out on to the main floor for loading, using the main cranes. This furnace has a chamber 35ft by 20ft by 20ft and is oil-fired.



Main steel fabrication area

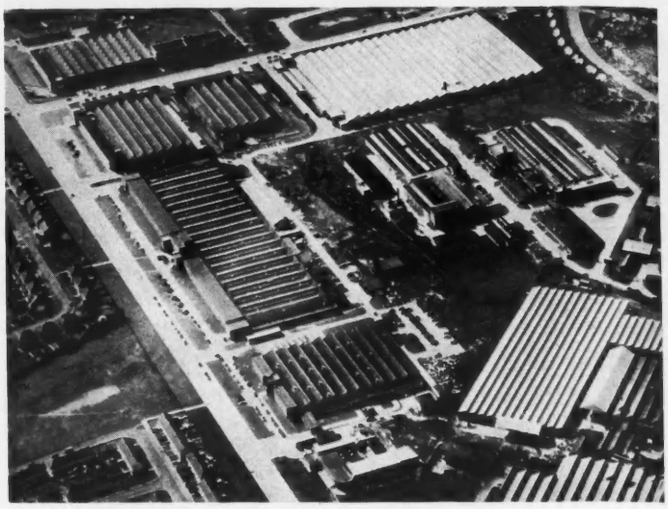
In this shop the bearing caps and other fabricated details for the stators are machined on a Kendall and Gent 6ft by 18ft plano mill, and this machine is also used to mill the keybars of the units. A 10in Asquith horizontal milling and boring machine similar to that in the turbine shop is used for machining the stator feet and end-shields. A machine of unusual design and construction in this shop is a Schiess vertical borer, used for the facing and boring of large stators. This machine is capable of boring frames from 7ft 6in to 10ft diameter and turning faces of frames from 10ft 5in to 15ft 6in diameter. The main structure of this machine is of reinforced concrete and the 24in diameter octagonal boring bar extends up 25ft from the centre of its pit to the level of the top of the two reinforced concrete side columns. The stator frames are lowered into the machine to register on adjustable bearing pads in the base of the pit, and when they are located a bridge is fitted between the columns. This bridge incorporates the upper support bearing for the boring bar and its driving motor.

It should be mentioned here that punchings for the stators are supplied to this factory from other works of the firm, as it has no press shop. The rotors are also built either at Rugby or Manchester and delivered to the factory for assembly with the stators.

For the erection and testing of alternators a large elevated bed which is long enough to accommodate two fully assembled alternator sets has been installed on one side at the extreme end of the shop. At the centre of this bed there is mounted the motor and gearbox used for driving the alternators undergoing test. Whilst one alternator is undergoing its running tests a second alternator can be assembled at the opposite end of the bed. At the conclusion of the tests on the first alternator the main motor and gearbox are disconnected from the bed and raised and turned by the overhead crane to present the driving end to the second alternator, which is then coupled up for its running tests. By using this system of turning the driving unit the two ends of the test and assembly bed are used to their fullest capacity and the amount of floor space occupied is reduced to a minimum.

I.P. and L.P. casings of a 120MW turbine being assembled on test bed

International Computors and Tabulators, Ltd.



THE works of International Computers and Tabulators, Ltd., was opened by the former British Tabulating Company, Ltd., in 1948, and it was one of the first factories to be established at Castlereagh. Over the past ten years its size has more than doubled to the present 500,000 square feet of productive floor area, and now it provides employment for some 2300 hands. Like other concerns introducing industries new to Northern Ireland, the firm at the outset was faced with the need for intensive training to provide skilled hands for its particular class of work. This task was undertaken by a nucleus of staff from the main works at Letchworth, and 80 per cent of the people now employed have been trained by the firm. The factory is now producing sorters, interpreters, collators, calculators, computers, electronic equipment and reproducers in addition to units, such as tabulator feeds and counters, for the parent factory in England. An essential feature in the integration of this factory's products with those of the parent works and delivery to customers is the speedy transport of equipment, which has to be handled with particular care. This problem has been overcome by the use of an air transport system from Luton which delivers motor-cars to Northern Ireland and, on the return service, enables I.C.T. machines and units to be delivered in England on the day of dispatch.

The factory comprises three main buildings of modern design, to be seen in our illustration above. The main machine shop is situated centrally in the largest building, which incorporates the administrative and design offices, and from this machine shop the components are fed to the two smaller buildings, where the equipment is assembled. The building on one side houses an electro-mechanical equipment assembly section and that, behind another factory, on the other side is devoted to the assembly of electronic equipment.

Following modern flow methods, the plant in the machine shop is arranged to give a natural progression from the raw material preparation stores in one corner directly to initial machining sections, including the press and sheet-metal areas and the turning lines at the end of the main floor. In these sections, as in the subsequent second operation lines concerned with milling, drilling, grinding, gear-cutting, &c., the work-flow is arranged from the outer sides towards a central aisle, where components are inspected and taken to a central main progress stores. All components are transported in containers of standard sizes and between individual operations are stored in the main progress department from which they are dispatched as required to the machine production lines. In this way a close central control is maintained over the planned schedule and the main production-floor area is kept clear of any work not in actual process of machining or about to go on to a machine.

Ancillary to the main production lines are sections concerned with heat-treatment, induction hardening, plating and painting, and a large well-equipped tool room at one end of the shop is responsible for making and maintaining all the jigs, fixtures, &c., used on the machine lines. Following modern practice, the grinding of cutting tools on the production floor is forbidden, and a central tool stores incorporates an inspection section into which all tools are sent on return from the lines to be checked. From this inspection tools requiring rectification or resharpening are sent to the tool room and those fit for further use passed back to the stores for re-issue.

The speed and degree of accuracy called for in operation of the machines built in the factory makes necessary a very high degree of accuracy in component manufacture, and the visitors will see some particularly interesting examples of modern close tolerance working. A fuller appreciation of the need for this accuracy is obtained in the electro-mechanical equipment shop, where the parts are assembled. The floor of this shop is divided into six main areas, each concerned with one class of unit or machine. When each unit is completed it undergoes an exhaustive inspection and simulated service running test, and then as each unit is assembled on its machine its performance in respect to previous units is checked and adjusted. In our illustration (below) there can be seen the lines engaged in the assembly of punching equipment.

Those not generally familiar with I.C.T. machines will find this shop particularly interesting and instructive—for to see the machines "growing" as the units are assembled along the lines gives a clearer picture of the principal operating features than is possible in words. They will see that, despite the complicated nature of the mechanisms and the high standards of accuracy required for acceptable performance, the amount of rectification on components and selective assembly involved is remarkably small. As a matter of interest, it should be mentioned that in a tabulating operation the time interval a hole in a passing card registers to actuate a counter magnet to trip the clutch of a recording wheel is about eight milliseconds. The speeds attained in operating are instanced by machines that can sort up to 600 cards a minute, tabulate the information detailed on up to 175 cards a minute and list or preset data from up to 120 cards a minute.

The electronic equipment section of the works is in the most recently completed building, and it is at present engaged in the production of computers and calculators, as well as parts for the larger tabulators being made in the parent factory at Letchworth.

For some time I.C.T., Ltd., has advocated the use of electronic computer equipment for production control in large factories, and a system has been installed recently for control-

Punching equipment assembly section of electro-mechanical department at I.C.T. works

Electronic computer equipment used for production control at Castlereagh works

ling its Castlereagh works. This equipment is laid out in a room which adjoins the main entrance hall and it can be seen in operation, as in our illustration, through a large window in the waiting room. In this system the computer provides a rapid and practical means for integrating stock control with production and in relating production to demand. With the basic information which is available of the capacity and facilities for every facet of production in a factory, the equipment enables the rapid preparation of a manufacturing programme without need for the lengthy calculations otherwise involved. It can be used to provide at short notice either advance or retrospective analyses of production and, when necessary, quickly replan production in a works.

Harland & Wolff, Ltd.

NO visit to Northern Ireland by an engineering institution would be complete if it did not include in its itinerary the world-famous shipyards of Harland and Wolff, Ltd., at Queen's Island, Belfast. The detailed history of the firm was given in a paper presented to the British Association in 1952 by Dr. Denis Rebbeck, but a few notes on its background should be included here as a matter of record. The foundations of the firm were laid in 1853 when Mr. Robert Hickson opened a yard for building iron ships on Queen's Island, and a year later appointed Mr. (later Sir Edward) E. J. Harland as manager. Within a short time from his appointment, the whole responsibility for running the new yard devolved upon Harland, who decided it would be better to work on his own account, and eventually, in September, 1858, he purchased the business from Hickson for £5000. He later invited Mr. Gustav Wilhelm Wolff to join him and shortly afterwards, in April, 1861, a partnership agreement was drawn up founding the firm of Harland and Wolff.

The first order placed with Harland was by J. Bibby, Sons and Co., of Liverpool, for three screw steamers—the "Venetian" (launched from Harland's only slipway on July 30, 1859); the "Sicilian" (launched November 12, 1859), and the "Syrian" (launched March 26, 1860) and the building numbers allocated to these three vessels were Nos. 1, 2 and 3 respectively. It is interesting to note that the number of ships which have been ordered from Harland and Wolff, Ltd., now exceeds 1600.

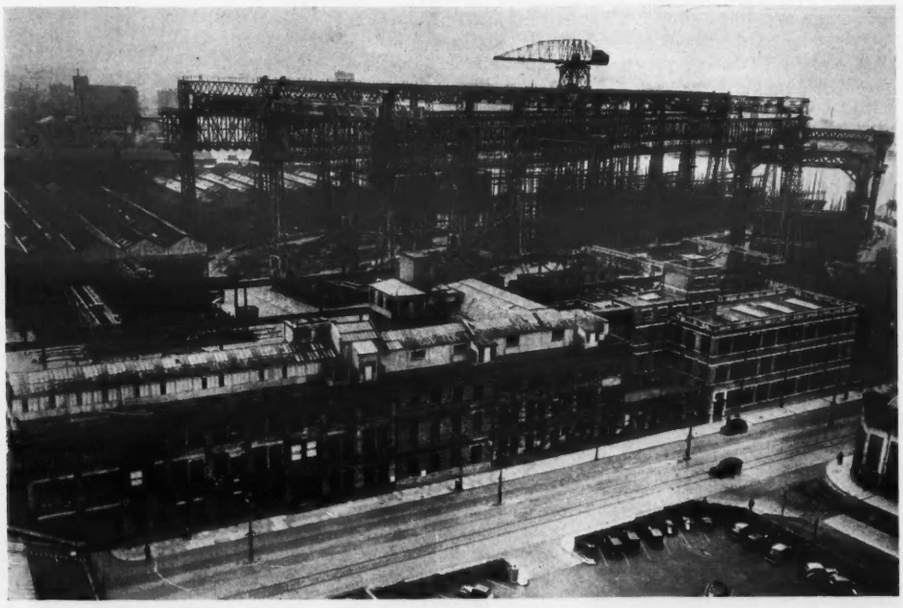
Edward Harland was succeeded at Queen's Island by another great shipbuilder, W. J. Pirrie, who had been one of Harland's first pupils, and who later became Viscount Pirrie. From its earliest beginnings the history of the firm has been one of continuous expansion and, under the guidance and leadership of the present chairman and managing director, Sir Frederick E. Rebbeck, who became chairman in 1930, the firm has continued to expand in all fields of modern shipbuilding and engineering. With branches at Glasgow, Liverpool, London and Southampton it is now the largest shipbuilding and ship-repairing organisation in the United Kingdom. At Queen's Island there are now eighteen slipways which include building facilities for vessels of over 1000ft in length. Three graving docks are available, the largest of which is 886ft long by 96ft wide at the entrance, and ample cranage facilities up to 200 tons lift.

Over the years the firm has built many noteworthy ships, including such famous vessels as the "Oceanic," "Majestic," "Olympic," "Titanic," "Britannic" and many other White Star vessels; the "Andes" for Royal Mail Lines, Ltd.; the "Pretoria Castle," "Pendennis Castle," and numerous other Union-Castle liners; the aircraft carriers "Eagle," "Bonaventure" and many others. The most noteworthy ship launched recently is the "Canberra" for Peninsular and Oriental Steam Navigation Company, which can now be seen at one of the fitting out berths. During the past twenty years over 100,000 tons of merchant shipping have been launched annually from the Company's Belfast slipways.

At Belfast the firm now has four shipyards—Musgrave, Queen's, Abercorn and Victoria—and the works and yards, which cover a total area of some 300 acres (including dry docks), provide employment for 20,000 hands. The largest ships, such as liners, aircraft carriers and large tankers, are built at the Musgrave and Queen's yards; medium tonnage cargo vessels and small warships are built at the nearby Abercorn yard; and dry cargo vessels at the Victoria yard.

The works at Belfast were extensively damaged by enemy air attacks during the last war. A rebuilding programme was undertaken, during which the opportunity was taken to install new equipment and generally to modernise the works. Amongst the recently installed equipment are cold-frame bending machines for sections, the latest flame-planing, plate-flatting and duplex profiling machines and a shot-blasting plant taking the largest plates and sections.

In addition to the platers' shops, there is a large central welding shop which has a floor area of 110,000 square feet; and head room for turning panels of over 40ft. This shop, part of which can be seen in a photograph we reproduce, is divided into two bays, one of 100ft and the other of 90ft



Part of the main office of Harland and Wolff, Ltd., and beyond, the gantries of the Queen's shipyard

Part of the large central welding shop

span. Each bay is provided with three overhead cranes, one in each bay having two independent grabs permitting two parallel single slings to be used in three-point turning of large panels. The exterior storage area, which is intersected by wide concrete roads leading to the slips, is served by two overhead gantry cranes of 125ft span.

The increasing use of aluminium in ship superstructures prompted the firm to set up a new aluminium welding shop for this class of work, and this shop has been responsible for the fabrication of the 1000 tons of welded aluminium superstructure used in the building of the "Canberra."

The relatively short time that members will spend at Queen's Island can give only a slight impression of the many activities and considerable size of the various sections associated with the Harland and Wolff organisation. The photographs we reproduce and the following brief notes will, however, give some idea of the firm's capacity and many activities.

The Queen's and Abercorn works together comprise a total area of 36 acres, which includes an outside storage area of 200,000 square feet. The shops include fitting, erecting, light and heavy machine shops, tool rooms, boiler shops, iron and brass foundries, pattern shop, smithy, copper shop, and fettling shop. An up-to-date chemical and metallurgical laboratory, and a radiographic laboratory, centrally situated, serve both the engine works and shipyards.

Queen's engine works is mainly devoted to the manufacture of diesel engines, steam and gas turbines and gearing of the largest powers for marine propulsion and, in addition, diesel engines for ships' auxiliary and land power duties from 6000 s.h.p. down to 250 s.h.p. A variety of gas-engine-driven reciprocating compressors are manufactured under licence from the Cooper-Bessemer Corporation as well as centrifugal compressors for the oil and other industries.

Diesel engines and turbines are erected and tested at the opposite ends of the largest bay, which is 1090ft long by 84ft wide and 67ft high and served over its full length by 160-ton capacity overhead cranes. The centre section of this bay contains the largest machine tools, which include two C.W.B.- Innocenti horizontal boring and milling machines having a horizontal traverse of 28ft and a vertical traverse of 16ft, and a 90ft Craven shafting lathe. One end of this bay can be seen in a photograph we reproduce, and its erection sections are supplied with the smaller components and units which are made and assembled in side bays.

At the south end of the bay is the gear-cutting department equipped for the production of gearwheels of 16ft 6in diameter or pinions and wheels of 6in diameter. There is also a comprehensive heat-treatment section covering nitriding, carburising, flame hardening, and a variety of other processes. The tool room includes a modern air-conditioned and temperature-controlled standards room in which all precision gauges and tools used in production undergo routine checks.

The engine works are virtually self-contained, apart from the supply of heavy forgings and steel castings and such items as pumps and other proprietary auxiliary machinery. They are supplied by four foundries, a light and a heavy iron foundry, and a light and a heavy brass foundry, which produce cast iron, nodular, and non-ferrous castings. The iron foundries are served by seven cupolas ranging from 3 tons to 12 tons, and the non-ferrous foundries by four reverberatory furnaces with capacities from 5 tons to 14 tons, and two 10 cwt and two 600 lb tilting furnaces. The boiler shop is equipped to deal with pressure vessels and other fabrications up to a maximum weight of 100 tons. A variety of marine boilers and waste heat boilers, &c., are also manufactured in these shops.

A new apprentice training centre recently opened at Queen's works caters for boys of all trades on the shipbuilding and engineering sides of the firm's activities and provides courses of instruction before they enter the engine works or the shipyard.

The manufacturing facilities of the firm's electrical department include the d.c. and a.c. equipment manufacturing shops in the King's works, and the Sydenham Road factory, which is responsible for the manufacture of control gear, switchgear, &c. The d.c. shop is engaged mainly in the

Heavy engine assembly end of the main engine erecting shop, Queen's works

manufacture and testing of dynamos and motors for electrical installations in ships, but the department undertakes, in addition, a large volume of work for shore stations, both at home and abroad. Additional shops and machines required for the development of a.c. equipment have also been installed to meet the growing use of a.c. equipment for modern ship applications.

Separate from the main engineering works, and covering an area of 16 acres, are the Victoria works, which, besides being engaged in the manufacture of marine and land engines and boiler installations, undertake also a full programme of repairing work. The engine and boiler shops in this section of the works are equipped with overhead travelling cranes of up to 60 tons capacity, and, like the main engineering shops, are connected to the fitting-out wharves by railway tracks.

The engine shop is well equipped with modern machine tools and the fitting and erecting section includes an engine-testing section where medium-sized diesel engines are built and tested (with their alternators) prior to being dispatched. A stress-relieving furnace which has been installed in the works is capable of dealing with very large fabricated components and also serves Queen's works and Victoria works.

The firm's steel constructional division at the Sydenham works is a self-contained organisation where the designing, fabrication and erection of all classes of structural steelwork are undertaken. Its main fabricating shop comprises two bays, with an extensive range of lifting, manufacturing and manipulating plant.

The remaining area of these works is utilised chiefly for the storage of materials and fabricated sections, for the handling of which overhead cranes of large span, and cranes travelling on rail tracks are provided. The rail cranes serve also as locomotives for hauling the special bogies on which supplies of steel for the fabricating shop are loaded.

Short Brothers & Harland, Ltd.

Short Brothers and Harland, Ltd., with its headquarters and main works at Queen's Island, came into being in 1936 as a result of an agreement between the two world-famous firms of Short Brothers, Ltd., and Harland and Wolff, Ltd. Its actual history in the aircraft industry goes back more than sixty years to 1898 when Oswald and Eustace Short, pioneers in lighter-than-aircraft, received a contract for the manufacture of a number of balloons for the Indian Government. With the advent of heavier-than-air craft they were joined by their brother Horace, an experienced engineer, and built the first Short powered aircraft which flew in July, 1909. The second aircraft, a biplane, was built soon after to the general specification of Mr. J. T. C. Moore-Brabazon (later Lord Brabazon) who flew it to win the £1000 prize offered by Lord Northcliffe for the first circular flight of 1 mile by a British aircraft. In 1908 the firm received the world's first aircraft production contract from Orville and Wilbur Wright for six biplanes. From that time on the company has been closely associated with the development of aircraft and flying-boats, and its name recalls many famous types, such as the " Sunbeam 225 " series of seaplanes ; the " Silver Streak," the first all-metal British aeroplane ; the " Cromarty," " Calcutta," " Sarafand," " Empire " and " Sunderland " flying-boats ; the " Stirling " bomber, and many others.

The firm now has three main factories at Queen's Island, two of which are concerned with aircraft assembly, and for several years past production has been devoted almost exclusively to military versions of the " Britannia " turbo-prop airliner and the " Canberra " P.R.9. Work on the " Britannic " long range freighter for R.A.F. Transport Command and on the SC.7 light freighter, a private venture, is now under way.

The illustration on this page shows one corner of the factory which is devoted to the assembly of "Canberra" P.R.9 reconnaissance aircraft and gives a good idea of the impressive size of the factory itself. Adjoining this assembly section is another concerned with the erection of " Britannia " aircraft. On their way to these assembly lines the visitors will pass through the main machine shop concerned with the manufacture of components. This machine shop of some 50,000 square feet is claimed to be one of the largest and best equipped in Europe. At present the tool room associated with this section of the works is engaged in building the jigs and fixtures for the construction and assembly of the new " Britannic's " and the size of this machine will be appreciated from the assembly jigs which are to be seen in course of erection.

The SC.5 " Britannic " freighter aircraft, has been designed specifically to carry the widest variety of cargo over long, short or medium ranges at low operating cost. Its freight hold is stated to have a cross section greater than that of any other aircraft in the world and a tail-loading ramp-type door gives unhindered access to any load which the fuselage can contain. Large military vehicles, guns and guided weapons can be accommodated and provision is made for dropping supplies by parachute.

The aircraft can carry its capacity payload of 85,000 lb over 1150 statute miles at 340 m.p.h., with 20 per cent fuel reserves, whilst, with a capacity fuel load of 81,000 lb, it can carry a 25,000 lb payload over 5050 miles at the same speed. Whilst the " Britannic " is essentially a freighter it can also be employed successfully as a troop-carrier or civil passenger transport, and for this purpose the design permits the installation of a removable upper deck. The aircraft can carry 201 fully laden troops or—used as a high density economy class transport—up to 255 civil passengers.

The SC.7 aircraft being developed as a private venture is a light-freighter machine which will carry a payload of one and half tons. It will be able to operate safely with a full load from any half mile long strip and, when required will parachute drop large loads.

A noteworthy machine designed and built by the firm under contract for the Ministry of Aviation and which has recently been in the news is the SC.1 " VTOL " aircraft. This machine is the only one in the world to employ its particular system of a battery of lift engines for vertical take-off, with a separate engine for forward flight. It is a small delta-wing aircraft with no tailplane. Four of its five RB.108 engines are mounted vertically in a central engine bay and the fifth exhausts horizontally at the tail, giving thrust for forward flight. This machine made aviation history in April last, when at the Royal Aircraft Establishment, Bedford, it achieved transition from jet-borne hovering to wing-borne forward flight and the reverse.

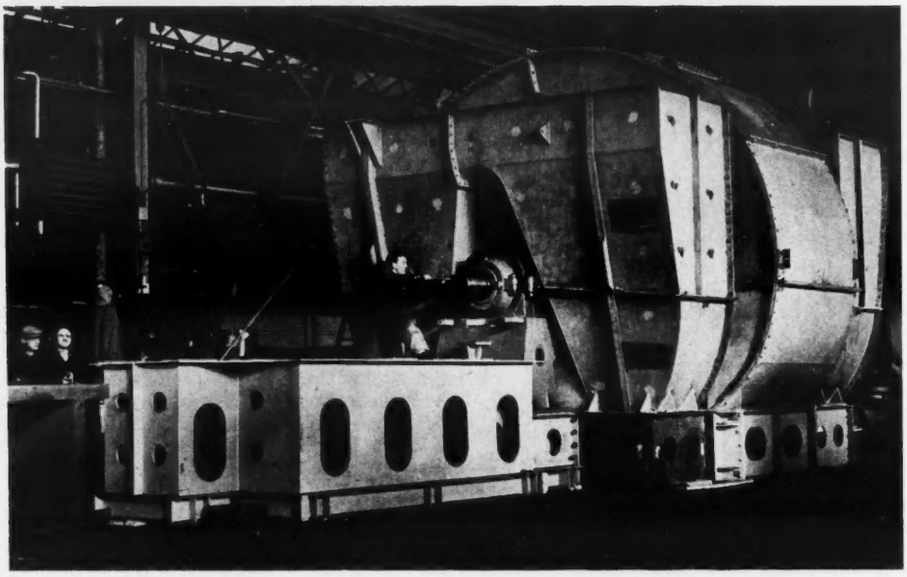
In addition to the main factory at Queen's Island the firm has a number of other works in the Belfast area where ancillary activities are controlled by its Precision and General Engineering Division. These other sections have been responsible for the development of the " Seacat " guided missile; an analogue computer now in series production; hydraulic systems for industrial applications; a straddle carrier; a freight lifting platform for loading aircraft, and a number of other projects.

" Canberra PR.9 " reconnaissance aircraft being assembled

Davidson & Co. Ltd.

Although the Sirocco works of Davidson and Co., Ltd., was opened in 1881, the foundations of this well-known firm were actually laid many years before when, in 1864, the late Samuel C. Davidson (afterwards Sir Samuel Davidson K.B.E.) sailed for India to become an assistant on a tea estate. Samuel Davidson had a very inventive strain and within a year or so was conducting his own series of experiments to improve the yield of the estate and to advance tea treatment processes. He achieved a considerable degree of success in both directions and it might well be said that his manufacturing career started in 1869 when he took out his first patent for a cylindrical leaf drying machine, to be followed a year later by a patent for a new tea roller. Over subsequent years Samuel Davidson made a number of further developments in his tea estate machinery. When he eventually returned to Belfast in 1881 he set up Sirocco works in a single shed with a staff of seven men to make machines of his own design.

The young firm made steady progress until 1898 when, in the course of experiments to determine an efficient fan for use in tea driers, the forward-bladed centrifugal fan was evolved. This outstanding development was an important step in the firm's history and probably more than anything else founded its future prosperity. The efficiency of this design of fan led to its rapid adoption by industry for mine and other ventilation systems, fume and dust removal, air conditioning plants, &c., Thus, the first tea drier and the centrifugal fan provided the main roots for the many products for which the firm is so well known and brought about the establishment of works now covering an area of some 12 acres and providing employment for over 1200 hands.



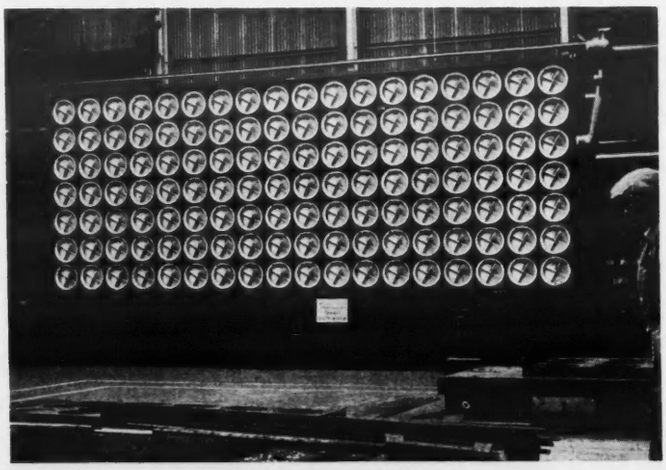
124in diameter fan for a steelworks sintering plant

It would not be possible enumerate the very wide range of designs and sizes of fan the firm is now making, but it should be mentioned that since the introduction of the original " Sirocco " forward-bladed centrifugal fan into the mine ventilating field the company has been intimately concerned with the development of mine ventilation generally, and it has designed and manufactured some of the largest axial flow fans installed in this country and overseas for mine ventilation. More recently, the firm's backward aerofoil bladed fans have been increasingly used for this purpose, and the visitors will probably see in course of construction three of these fans of up to 141in diameter in the shops. These backward-bladed fans have hollow sheet steel aerofoil blades and they are designed to deliver almost constant air volumes over a range of pressures. Typical of this design of fan is the 124in diameter unit illustrated on this page, which was built for a sintering plant at a British steel works. It has a duty of 275,000 c.f.m. at 24in S.W.G., handling gases at 250 deg. Fah. (750 r.p.m. and 1350 b.h.p.). It is designed to work in conjunction with a 180 cell " Sirocco " cellular collector.

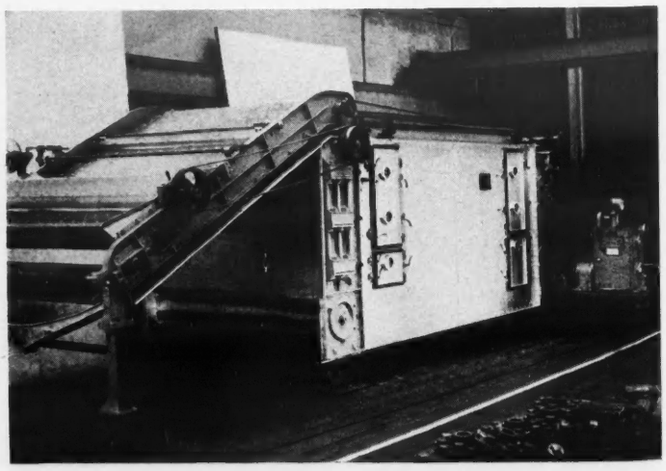
One of the large axial flow mine fans recently built by the firm is of 165in diameter three-stage design and has adjustable stainless steel blades. It is capable of moving 34,500 tons of air per twenty-four hours. The total weight of this fan together with its shaft and rotor hubs is approximately 60 tons. The design duties of the fan are 400,000 c.f.m. at 8in S.W.G. (258 r.p.m. and 655 b.h.p.) and 700,000 c.f.m. at 9in S.W.G. (258 r.p.m. and 1340 b.h.p.).

Some years ago the firm introduced the cellular dust collector and a typical 126 cell collector panel of this design is illustrated below. This collector comprises a sheet steel panel structure, into which are built a number of horizontal cells, each of which is designed to deal with a certain volume of dust-laden flue gas. Stationary guide vanes in each cell impart an intense swirl or vortical action to the dust-laden gas so that the dust, thrown outwards centrifugally, is carried to the outlet end of the cell, and is " airborne " by a small quantity of gas through an annular slot into the dust header, while the main volume of gas from which the dust has been removed passes on through the clean gas outlet. The gas which carries the dust through the annular slot into the dust header is exhausted by a booster fan through a secondary collector system. The dust passes into airtight hoppers or through automatic discharge valves. Collectors can be fitted with alternative forms of guide vanes giving different degrees of swirl in accordance with the specified duties.

Representative of the many classes of machines made by the firm for tea estate factories is the endless chain pressure tea drier we illustrate. This tea drier consists of a sheet metal chamber through which hot air is blown whilst the tea is fed in by



Cellular dust collector panel under construction

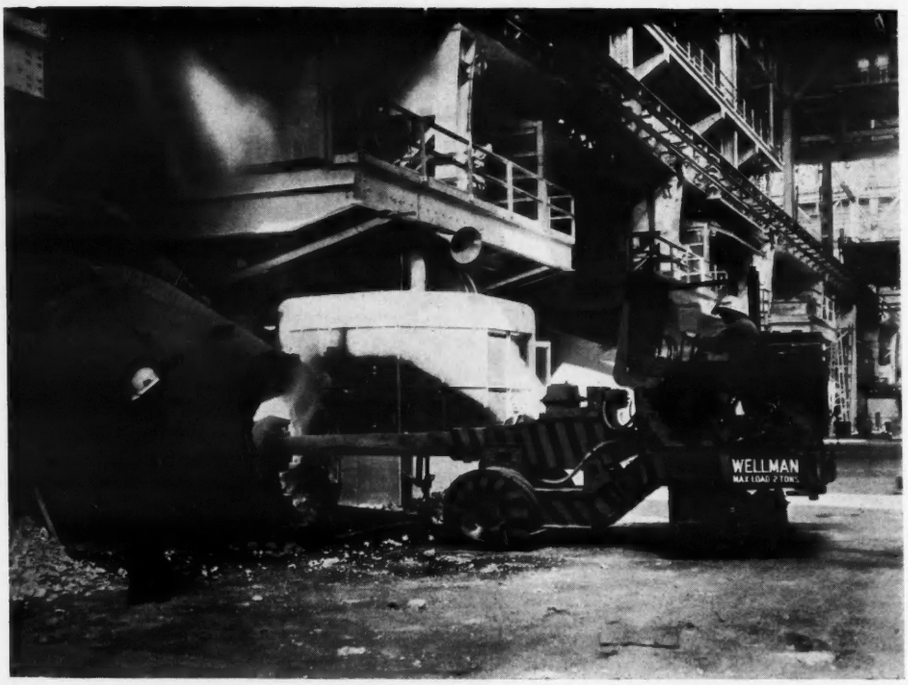


Tea drying machine

a conveyor at the top at one end. The tea falls into a series of trays in which it is carried backwards and forwards in a series of parallel paths along the chamber length by an endless chain. At the end of the final path the dried tea falls on to the inclined base of the chamber and gravitates out of the end. A variable speed gearbox through which the chain is driven sets the speed in accordance with the condition of the tea.

The Wellman Smith Owen Engineering Corporation Ltd.

When the Falls Foundry Engineering Works, Belfast, was acquired by the Wellman Smith Owen Engineering Corporation, Ltd., in December, 1955, the complete plant, which consists of machine shops, erecting shops, foundry and administrative buildings, was taken over as an operating unit and continuity of employment was given to all workers and staff employees of the previous owners. The decision to set up an establishment in Northern Ireland was made to provide increased manufacturing capacity greatly needed by the Wellman Corporation, and the firm was attracted to Belfast by the plentiful supply of labour and the financial assistance and other facilities provided by the Government.



2-ton mobile bar-turn furnace box-charging machine

The completely new range of heavy and medium engineering products which the works was called upon to produce involved a considerable amount of retraining of the existing labour force, which proved adaptable and co-operative, and to provide for the training of future personnel an apprenticeship scheme has been established. In order to provide increased efficiency and to deal with the expanding demands on the Belfast establishment, the engineering shops have been modernised and almost completely re-equipped with modern machine tools.

The works is a balanced manufacturing organisation from the design stage onwards and its efficiency compares with that of the main Wellman works at Darlaston, South Staffs., to which it is complementary. At this works production is concentrated on the lighter specialities in the Wellman range, such as mechanical handling and processing units for the production of steel strip, mobile charging and handling machines, air control valves and component parts for the heavy steel works equipment produced at the main works in England. Typical of this equipment is the 2-ton mobile bar-turn furnace box-charging machine illustrated, which was supplied to the Steel Company of Wales. This machine is driven by a diesel engine and all of its motions are hydraulically operated. It is of interest to note that the Belfast works has contributed to the large volume of plant which the Corporation has supplied, comprising the complete open hearth department of the new steel works now being erected at Durgapur for the Indian Government.

Other Works to be Visited

The assembly lines of the Corran Works, Ltd., at Larne, where domestic radios in large numbers are assembled by flow-line methods, will prove an interesting contrast to the engineering and other works being visited. These hand assembly lines have an attraction for the engineer and the non-technical visitor alike, for they not only demonstrate the high degree of dexterity on the part of operators but also provide an interesting study in the breaking down of operations to ensure the maintenance of a constant work flow. Another class of high production work will be seen at the factory of the U.K. Optical Bausch and Lomb, Ltd., Lurgan, where spectacle frames and lenses are being manufactured.

Two firms established in Northern Ireland by companies in the United States which are to be visited are mainly engaged in manufacturing equipment for the oil industry. One of these factories is that of the Mission Manufacturing Company Ltd., at Cregagh, near Belfast, where there are made expendable parts for the slush pumps used for pumping special mud during the sinking of exploratory oil well shafts. In the main the parts made consist of pump liners and rubber-sleeved pistons which are a precision fit in the liners.

The Hughes Tool Company Ltd., at Castlereagh, was established by the parent American firm in 1954 and its present factory occupies about 100,000 square feet, providing employment for some 300 hands. It manufactures rotary rock bits for the oil industry in a range of sizes and types for drilling all classes of hard and soft rock formations. Each of these bits consists of a heavy forged and welded shank assembly carrying three sets or " cones " arranged in a triangle and rotating on ball and roller bearings on pins integral with the shank. Rings of deep, chisel-shaped teeth machined on the cones are hard faced with tungsten-carbide and their spacing and shapes are designed to suit different rock formations and operating conditions. When the bits are rotating at the bottom of a hole the toothed cones, according to their design, impart a twisting, tearing and gorging action on the softer forms of rock and a rolling/chipping/crushing action in hard formations.

Turning to the factories not actually concerned with engineering there is the works of Courtaulds, Ltd., at Carrickfergus, where viscose rayon yarn is produced by a continuous spinning process. This factory, situated in a 275-acre site in ideal surroundings, was opened in 1945 and was initially engaged in the production of viscose textile yarn for apparel, furnishing and household textiles ; by 1953, however, special high-tenacity viscose yarns for tyre cords and other industrial purposes were also being produced, and the output is now of the order of 17,000,000 lb of yarn a year.

Most of the high-tenacity rayon produced at the factory is supplied directly to the Dunlop tyre factory at Londonderry. For this transport service there are used special trolleys, which are loaded directly into vans provided by the Ulster Transport Authority, so that need for packaging is eliminated, handling of the yarn is reduced, and quicker delivery results.

The constituent raw material for viscose rayon is cellulose, which is imported as sheets of pulp, and the principal chemicals used in the process are caustic soda, carbon-disulphide and sulphuric acid, the last two being manufactured at the factory. The process also requires very large quantities of water, and of about 17,000,000 gallons per week supplied from the Woodburn system of the Belfast Water Commissioners, 13,000,000 gallons are softened on the site.

Belfast being the centre of the Irish linen industry it naturally follows that visits have been included to textile establishments and the programme covers tours of a linen weaving factory and a flax spinning mill as well as the works of Berkshire Knitting (Ulster), Ltd., where ladies fine gauge nylon stockings are made.

Republic of Ireland

For some years the Government of the Irish Republic has been giving every encouragement to the establishment of new industries by overseas firms, and as a result of its campaigning, some seventy foreign concerns have set up new factories in the country. Last year alone thirteen factories in which foreign interests participated commenced production, and a further twenty factories were under construction or being planned.

Of the country's 3,000,000 population some 436,000 are employed in agriculture and 284,000 in industrial production. Although the number at work in industrial production is much lower than the number at work in agriculture, the contribution made by industry, over the five-year period from 1952-1956, accounted for 24 per cent of the national income as compared with a 31 per cent contribution by agriculture. Gross industrial production which in 1946 amounted to £155 million rose to £411 million in 1955 and to £414 million in 1957.

To encourage further industrial development, particularly new export industries, the Government is prepared to make considerable tax concessions ; grant financial aid towards building, machinery and plant costs ; and assist in labour training. Recent developments of regional interest include the development of an industrial estate at Shannon Airport, which enjoys special concessions with respect to customs and taxation, and the construction of a shipyard at Cork. Last September there was opened the Whitegate refinery at Cork, which has a designed capacity of 2,000,000 tons, and was promoted jointly by three oil companies.

Works to be Visited in the Irish Republic

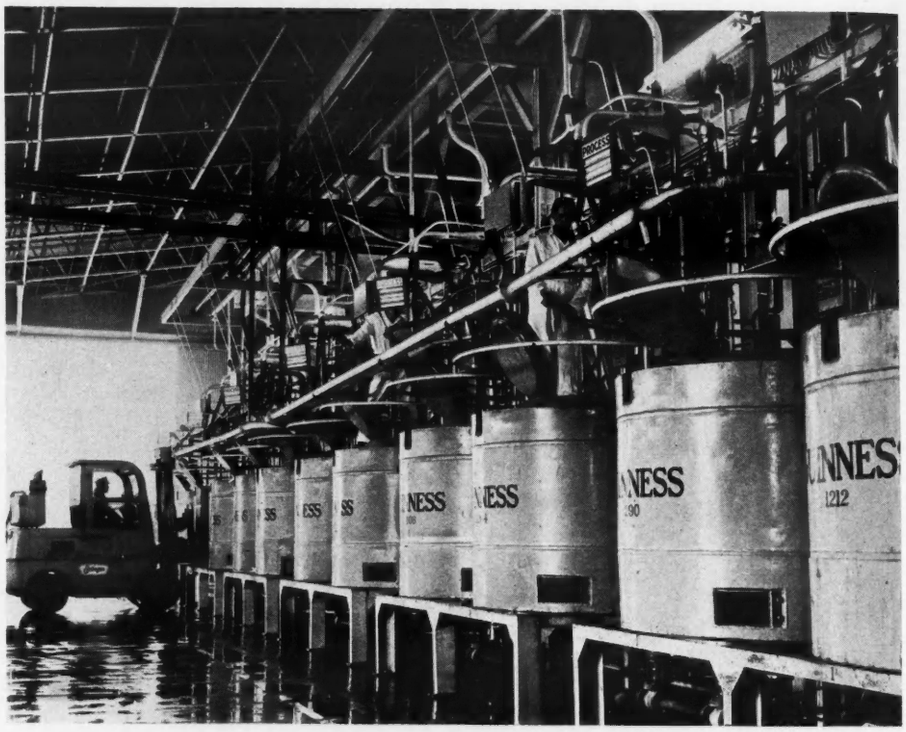
Although the members of the Institution will only spend a relatively short time in the Republic of Ireland an interesting choice of visits has been arranged to factories, in addition to the works of the Electricity Supply Board, the Irish Railways and Bord na Mona. The factories to be visited include those of the Unidare, Ltd., organisation, Irish Ropes, Ltd., Clondalkin Paper Mills, Irish Glass Bottle Company, Ltd., Gateaux, Ltd., and the brewery of A. Guinness, Son and Co. (Dublin), Ltd.

Unidare, Ltd.—The firm of Unidare, Ltd., started in a single factory at Finglas, near Dublin, only twelve years ago and the organisation to which it has now grown occupies a 65 acre site with six works served by common central buildings concerned with power and water supply, research, and other facilities. The original factory was built and equipped for the manufacture of overhead conductors and pole-mounting transformers for the extensive electrification scheme being carried out in the country at the time. The range of products steadily increased as extensions were made to the factory and it is now making conductors of up to sixty-one strands, transformers up to 5MVA, storage heaters, infra-red heaters and a variety of other electrical heating equipment.

The second large factory, the Ferrodare Works, which was opened some seven years ago introduced a new industry to the site—the manufacture of barbed wire, wire netting, fencing wires and industrial steel wires. In addition to fence wire products this works is equipped with a continuous casting and rolling mill for aluminium rod, which is drawn and stranded in the manufacture of overhead conductors in another part of the factory. At about this time the firm produced the first polythene water tubing in Ireland and began the manufacture of electrically-driven pumping sets and water supply systems.

In order to provide the variety of ferrous and non-ferrous castings required for the equipment made in the different factories a foundry was opened by the firm some four years ago. This foundry is equipped for the production of shell mouldings as well as for conventional sand castings. More recently a factory was laid down for the manufacture of all types of aluminium foil, aluminium and brass extrusions, aluminium sheets, and polythene film for the packing industries.

On the same factory site there is now a works of Telecommunications, Ltd., an associated company of Unidare, Ltd., and Pye Telecommunications, Ltd., of Cambridge. This modern, well-equipped factory includes a development laboratory and is engaged in the manufacture of radio, telephone and line carrying equipment.



Part of Guinness brewery tank station where bulk transport tanks are sterilised and filled

Section of the works of Irish Ropes, Ltd., equipped for the preparation of fibre for spinning into yarn

Irish Ropes, Ltd.—At the works of Irish Ropes, Ltd., which was established over a quarter of a century ago by the late Eric Rigby-Jones, there will be seen the many operations which are involved in the manufacture of ropes, cords, twines and carpets from sisal, manila, jute, cotton, hemp and flax. One of our illustrations shows a typical section of this modern works which is engaged in the preparation of fibre for spinning into yarn.

Arthur Guinness.—The product of the St. James's Gate Brewery of Arthur Guinness, Son and Co. (Dublin), Ltd., is too well known to need description. This brewery was started some two hundred years ago, when the first Arthur Guinness, employed the motive power of one horse to grind the malt, while crude direct firing was used for boiling the " wort," &c. Mechanical power was introduced with the first steam engine and a " haystack " boiler installed in 1811, and the first introduction of electricity was with d.c. electric lighting in 1883. This was followed by two 60kW Parsons turbo-d.c. generators in 1895, which supplied power for all the electric motors in the brewery.

In this brewery, which now employs about 4000 people and has 64 acres of covered floor area, 40,000 tons of fuel and 1,000 million gallons of water are consumed annually in the production of stout, the daily output of which reaches 360,000 gallons.

The water used in brewing is obtained from springs in County Kildare and is delivered from filter beds, 5 miles out in the country, through underground pipe lines. In addition to the malt, hops and barley used, an important part of the process is the " Guinness yeast," which is the direct descendant of that developed in the early days of the firm. After each brewing, only the purest and best yeast is kept for subsequent brews, the remainder being separated in rotary vacuum filters and dried for sale.

The brewing process may be summarised by the successive operations of :—water purification, distribution and heating ; handling and storage of malt, hops, and barley flakes ; grinding of malt and " mashing " with water and flakes in the " kieves " or mash tuns to form " wort " ; boiling this " wort " with hops in steam heated coppers; cooling the wort, oxygenating it and " pitching " with yeast on its way to the fermenting tuns ; fermenting the wort in tuns so that it becomes beer ; skimming the beer in special vessels to remove yeast ; and storing the beer at controlled temperature in vats. The stout is then made up in vats and piped either to machines where sterilised casks are filled, or to one of the tank stations shown in our illustration, where tanks for bulk transport are sterilised and filled.

Electricity Generation

The generation and supply of electrical power in the Republic of Ireland is in the hands of the Electricity Supply Board. The Board operates a system in which power is generated from hydro-electric sources, from power stations burning native peat, and from dual oil/coal stations burning imported fuel ; one power station burns native coal.

Slightly over a third of production is from the hydro-electric stations, and slightly under a third from the peat-burning stations. The hydro-electric stations are small run-of-river installations with heads of less than 200ft. In only one case is there appreciable storage, that is at the head of the three stations on the Liffey, where the Pollaphuca reservoir has a storage capacity of about 150 million cubic metres, which is equivalent to about 50 per cent of its annual output. The three stations on the Liffey together generate 41 by 10^6 kWh in an average year.

Hydro-electric production, therefore, is likely to fall off in the summer months. The peat harvest too, is vulnerable to weather conditions, and a dry summer is essential for a good harvest. At first sight this combination of sources seems ideal, a dry summer yielding plenty of peat and a wet one plenty of water power, but in practice this may not be so. A dry spell in November, for instance, as was recently experienced, reduces hydro-electric output at a time when it is too cold for the peat to dry. The sensitiveness of these two sources of power to the weather accounts for the rather high margin shown in the table, between total installed capacity and maximum load demand. Meeting the winter peaks is not at present a critical problem, for the installation needed to meet adverse conditions in the summer, should both peat and water sources be short, is adequate for the winter peaks.

The supply system is also characterised by the transmission of rather large quantities of power in relation to the total over long distances. The hydro-electric stations on the rivers, and the peat stations on the bogs, are both remote from the load centres. Main transmission is on a 110kV grid.

The hydro-electric resources of the Republic are about 75 per cent exploited by existing power stations. The remaining sites are thought to be too unfavourable for economic development under present day conditions. One station in the network—Arigna—which was completed last year, burns native coal, which is a fuel with a high ash content of 25-30 per cent. Provision for dual firing from either coal or oil has proved advantageous over the past few years, for the three large stations which utilise imported fuel. The cheaper fuel has been chosen, as prices have fluctuated, and it is thought that with completion of the refinery at Cork, a favourable source of supply for the Marina Station has been established. The fourth station listed in the coal/oil group, the Pigeon House station at Dublin, is an old station, which was modernised in the period 1933-40, and it now serves purely as a stand-by.

Present plans for increasing the capacity of the network are centred on the utilisation of peat, and it is this development which is likely to prove of the greatest technical interest to members of the Institution in their summer visit. Winning the peat, the responsibility of Bord na Mona, is described in another article. Here we are concerned only with the Electricity Supply Board's side of the problem, i.e. from the time the peat is delivered to the power station.

It should be emphasised that peat is not fully competitive in cost with the two other major sources of power in Ireland, but in the most recent milled-peat stations the difference in cost per unit generated is marginal between peat and coal or oil. Development has been carried on as a matter of national policy, not only because the economy benefits from utilising an indigenous fuel, but also because the peat industry has brought employment in the rural areas of the Republic, where such measures are most needed.

This " social " aspect of the use of peat in power stations is shown particularly by the four " hand-won " stations listed in the table, which are situated in rural areas in the west, where employment is an urgent need.

Apart from these minor power stations however, development is grouped around the major bogs where the power stations have been designed to have a life of about 25 years, corresponding to the total output which can be won from the bogs in that area. With the developments listed in the last section of the table, where we have quoted the ultimate installed capacities of the projected stations, utilisation of peat on the scale necessary for power generation, will it is thought, be nearly complete. These extensions, however, are sufficient to cater for the growth of the supply network until about 1968.

Two problems present themselves in the utilisation of peat in power stations, namely (*a*) handling and (*b*) combustion. The calorific values of the fuel are, in comparison with conventional fuels, as follows : milled peat at 55 per cent moisture content 3360 gross B.Th.U./lb ; sod peat at 35 per cent moisture 6200 gross B.Th.U./lb ; steam coal 12,000 gross B.Th.U./lb ; fuel oil 18,000 gross B.Th.U./lb. Much greater quantities of fuel have to be handled in relation to the power output than with coal — twelve times as much by volume in the case of milled peat. And in the boiler it is not solely a problem of burning a low grade fuel with a high water content, but variations in water content and density must also be allowed for, since blending is out of the question with the large quantities consumed. Brown coal at around 60 per cent moisture content is successfully burned in Germany, but it has a relatively constant composition. By contrast milled peat may vary from 40 per cent to 65 per cent.

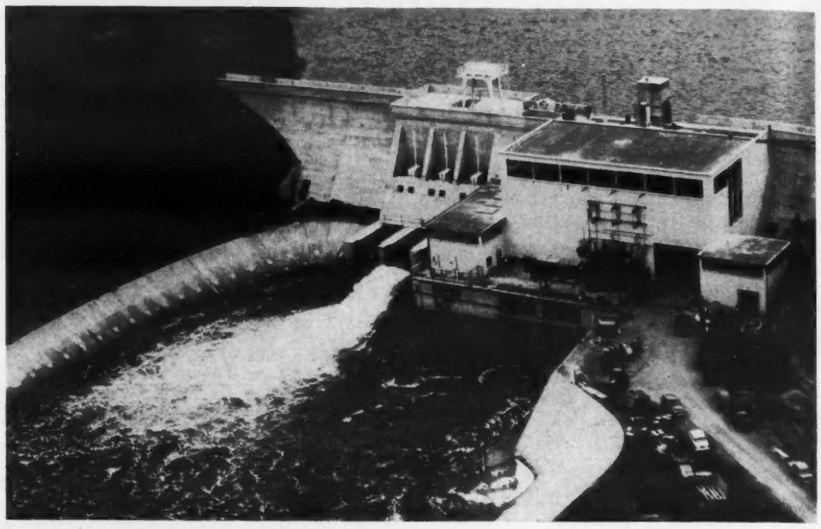
TABLE—*Electricity Supply Statistics for The Irish Republic*

For year ended March, 1959 :	
Installed capacity :	
Hydro-electric	219MW
Steam	469·5MW
Total	688·5MW
Units sent out	1810×10^6kWh
Maximum daily generation	7887×10^6kWh
Maximum load generated	462MW
Annual load factor	46·8
Hydro-electric Power Stations :	
River Shannon :	
Ardnacrusha	85MW
River Erne :	
Cliff	20MW
Cathaleen's Fall	45MW
River Liffey :	
Pollaphuca	30MW
Golden Falls	4MW
Leixlip	4MW
River Lee :	
Carrigadrohid	8MW
Inniscarra	19MW
River Clady :	
Clady	4MW
Peat-Fired Power Stations :	
(*a*) Sod Peat :	
Portarlington (Co. Leix)	2×12·5MW
Allenwood (Co. Kildare)	2×20MW
Lanesborough (Co. Longford)	20MW
(*b*) Milled Peat :	
Ferbane (Co. Offaly)	3×20MW
(*c*) Hand Won Peat :	
Gweedore (Co. Donegal)	5·3MW
Milton Malbay (Co. Clare)	5·3MW
Screeb (Co. Galway)	5·3MW
Cahirciveen (Co. Kerry)	5·3MW
Coal and Oil-fired Power Stations :	
Pigeon House, Dublin (stand-by)	95MW
North Wall, Dublin	1×12·5MW 2×16MW
Ringsend, Dublin	3×30MW
Marina, Cork :	
Present	2×30MW
Planned extension	1×60MW
Coal-Burning Power Station :	
Arigna, Co. Roscommon	1×15MW
Milled-Peat-Fired Stations, under Construction or Planned :	
Rhode (Co. Offaly)	2×20MW 1×40MW
Ferbane (Co. Offaly) additional set	1×30MW
Shannonbridge (Co. Offaly)	2×40MW
Bellacorick (Co. Mayo)	2×20MW

Note : See map on page 2 for positions of power stations.

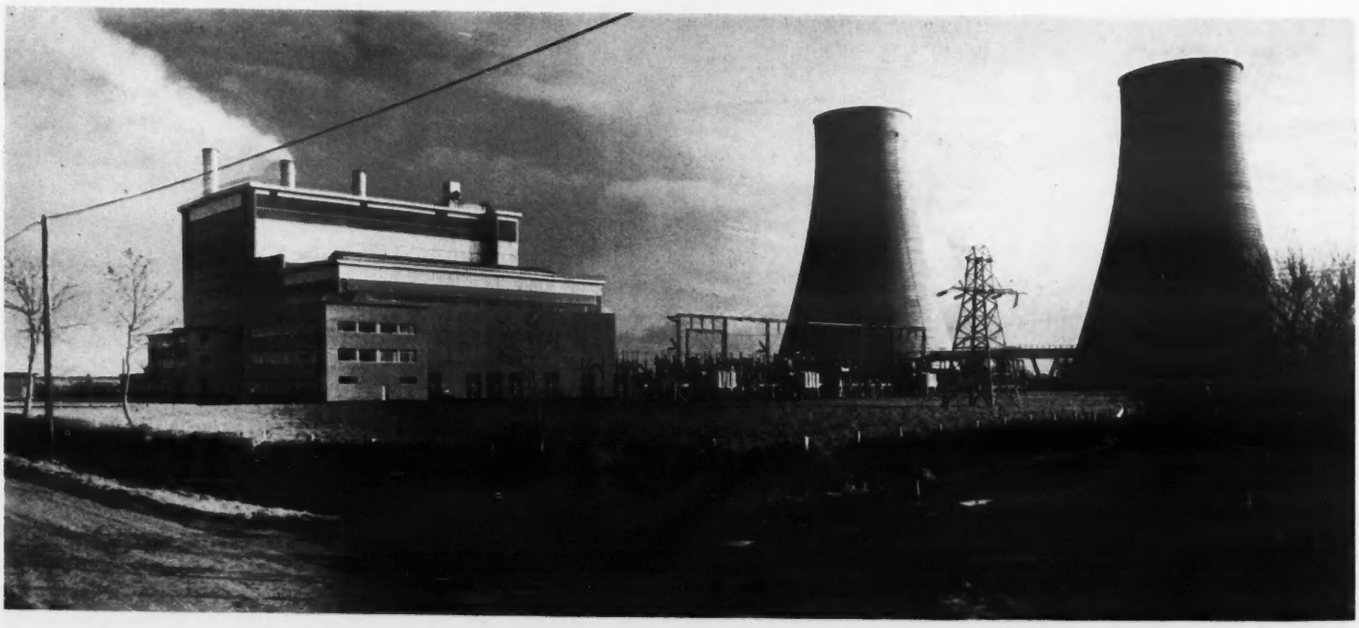
Power Stations in the Irish Rebublic

The two power stations on the River Lee were brought into use in 1957. The upper station at Carrigadrohid, illustrated on the RIGHT, contains one 8MW generating set, operating under a head of 45ft, and powered by a Kaplan turbine. The average annual output of this set is 17,000,000 units, and the station is remotely controlled from the lower power station at Inniscarra. The latter consists of a power station with one 15MW and one 4MW set, built at the toe of a buttress dam, which gives a head of 100ft. Power is generated at 10kV, stepped up to 110kV, and transmitted by overhead line to Kilbarry on the outskirts of Cork.



Portarlington generating station (LEFT) burns sod peat, a stock of which can be seen in the foreground, together with the narrow gauge railway from the bog and other handling plant. The capacity of the stock is 30,000 tons. The boiler plant in this station comprises three 125 klb per hour boilers; the sods—each about 10in long by 3in square—pass into a retort where they are dried with heated air, and then on to a chain grate stoker. The steam conditions are 425 lb per square inch and 825 deg. Fah. at the boilers Two 12.5MW turbo-alternators are installed.

Ferbane generating station (BELOW) is the first full-scale power station in the western world to burn milled peat (i.e. dust up to $\frac{1}{2}$in). Three 20MW generating sets were installed in 1957, supplied by three boilers, each of 176k lb per hour economic rating at 425 lb per square inch and 825 deg. Fah.



moisture, and there is a tendency to slagging at the lower figure and furnace pulsations at the higher one. Nevertheless the Ferbane station has now been operating successfully since 1957 burning about half a million tons of milled peat annually, and future plans envisage 40MW unit sets with milled-peat-fired boilers.

The three sets now in use at Ferbane each have slightly different boilers. The general design now favoured comprises four hammer mills to control the size of the milled peat particles (the name " milled " peat refers to the harvesting and not to this process) and fed with furnace gas, from which the fuel is fed to four corner burners in a rectangular combustion chamber. The steam conditions are 430 deg. Cent. and 31 kg/cm². For a full description of the boilers, we would refer the reader to an Institute of Fuel paper, viz : " The use of milled peat in large boilers for the generation of electricity " by Mr. J. F. Cullen, read in Dublin on January 20 last ; and for the handling problems " The handling of milled peat at power stations " by Messrs. A. G. Kelly and S. F. Coakley, read before the Institution of Mechanical Engineers in Dublin last February. Briefly the Ferbane installation handles trains of 5-ton wagons, automatically handled by a tippler at a rate of one per minute. Conveyors of 300 tons per hour capacity carry the peat from the tippler to three bunkers, each of 250 tons capacity, from which conveyors feed it into the boilers for combustion as just described.

Milled peat, although inferior to sod peat in calorific value, allows complete mechanisation of all the harvesting and burning processes. The first set at Rhode power station—the second power station to use milled peat—is due to go into operation this month. Like the three sets already in use at Ferbane this set will be of 20MW nominal capacity. But as can be seen from the table, sets of 40MW capacity are to be installed under the present constructional programme, burning milled peat. Bellacorick station is at present under construction and is due for completion in 1962-63 ; Shannonbridge has not yet been started, but enquiries for the main generating plant have been issued.

Utilisation of Peat

In the previous article on electricity generation, the importance of peat-fired power stations was explained, and it was also pointed out that, although marginally more costly than imported fuel, peat was being utilised as a national policy. The development of the Republic's resources of peat is in the hands of a public body Bord na Mona, or the Peat Board, as it is known, which is responsible for winning the peat from the bogs and supplying it to the power stations, and also for developing other markets for it. The board is in some ways rather similar to the North of Scotland Hydro-Electric Board ; not, of course, in the actual job which it does, but in its relation to the economy of the rural areas which contain the natural resource which it exploits. Bord na Mona is, for instance, a large-scale employer of local labour, and the Board has built new villages and generally is a stimulus to the rural economy in the districts where the large bogs are being worked. On the technical side, the Board's research station is a noteworthy feature of its organisation. The initial work of the station was the investigation of new methods and machines for peat winning, but more recently attention has been turned to proving the suitability of domestic appliances, such as stoves, for use with peat briquettes. As one result of the laboratory's work, all aspects of the peat industry in Ireland are well documented and, indeed, an international symposium on peat was held in Dublin a few years ago.

Peat is utilised as sod or milled peat—corresponding to the two mechanical methods of harvesting—as briquettes, which are a relatively high grade, smokeless fuel made from either of the aforementioned primary sources, or as peat moss. Peat moss is made from the light, upper layers of certain bogs and is used as a soil conditioner in horticulture or as litter for farm animals ; the board is developing markets of this kind and has, for instance, marketed a potting compost based on peat moss.

The present programme of Bord na Mona aims at the production annually of about 1,000,000 tons of sod peat, 3,000,000 tons of milled peat, 250,000 tons of briquettes, and 500,000 bales of peat moss. About 120,000 acres of bogs have been purchased for this programme, the principal groups of bogs being at Clonsast (Co. Offaly), Derrygreenagh (Co. Offaly and Co. Westmeath) Ballydermot and Timahoe (Co. Offaly and Co. Kildare) and Boora (Co. Offaly). The minimum size of bog which can be effectively utilised is about a square mile, and an initial depth of, say, 30ft or so, but the depth of peat in the bog will, of course, reduce very considerably as the bog is drained. The earlier system of mechanised harvesting, sod peat, is described first.

Sod Peat

The peat bog as found in nature has rolling contours broken by lakes and pools, but generally a crust of relatively hard material, which, with care, can be walked upon. The water content in this condition is about 95 per cent. The first step is to drain the bog. Tractors with bog shoes giving a bearing pressure of only 1 lb per square inch are driven across the bog, each pulling a plough, (alternatively draglines can be used). The plough is carried on big wheels, which have about the same bearing pressure as the tracks of the tractor, and it cuts a shallow trench. These trenches serve both to mark out the bog and to provide initial drainage.

As the bog degins to drain, it becomes progressively firmer. The trenches can then be deepened. The heading illustration shows the machine used for this purpose, a disc ditcher. The cutting disc, as can be seen, is set slightly skew to the axis of the trench to give the required cross-sectional shape, and as the disc rotates it flings the peat clear of the ditch. The bearing pressure of this machine is 1 ·7 lb per square inch. The depth of the trench, as shown in the illustration, is 4ft 6in, but this can only be achieved by cutting successively deeper at intervals, and allowing drainage to progress gradually. As progress is made, the main drains are supplemented by tunnel cross drains, for which various machines are used. Eventually, the main drains are excavated to the full depth of the bog, perhaps some 12ft deep. Drainage is a lengthy business, and in conjunction with other preliminary works, viz. preparing the surface of the bog by levelling, it will be two or three years before the bog is ready for production. However, the water content of the peat will have been reduced from about 95 per cent to about 90 per cent, i.e. half the water in the bog will have drained off.

The principal machine used in winning the sod peat is called a " bagger." It is an elaborate machine, which carries out three main operations, namely cutting, macerating and spreading. The machine itself travels along a prepared path beside one of the deep ditches, or beside an area already worked. A series of cutting buckets, arranged in a continuous chain in the manner of a bucket dredger, cuts the near-vertical face of the bog to the full depth of, say, 10ft, and to a width of about 6ft. The cut peat is discharged on to an inclined belt conveyor, which takes it to a worm-feeding device. The latter supplies the macerator, which is, in effect, two opposed screw cutters which mix the peat and then extrude it, as two rectangular " sausages," on to a conveyor carried by the spreader arm of the machine. In our illustration of the " bagger," the spreader arm is shown in the foreground and the twin extrusions can be clearly seen travelling out on the conveyor. The spreader arm extends for about 200ft across the bog. When the peat extrusions reach the far end of it, the conveyor is tripped, and they fall off. The trailing discs then cut the extrusions into sods.

Quite a lot of development work has gone into the perfection of the " bagger," which is capable of working forward across the bog

at a rate of about 60ft per hour, and producing sods at a rate of 100 tons per hour. It is electrically powered, with hydraulic control for the forward speed. There are three principal motors, for travelling 15 h.p. ; excavating 25 h.p. ; extrusion and spreading 120 h.p. The purpose of maceration is to produce a better sod which shrinks evenly into a dense product on drying, and is more resistant to subsequent water penetration than hand-won sods.

The sods spread out on the surface of the bog now undergo a harvesting cycle of about three months. An initial period of drying, reduces the moisture from 90 per cent to about 75 per cent; they are then collected into windrows; later on, the windrows are turned, and by this stage the water content should be about 60 per cent. Should the weather be bad, and the sods not dry out, they are more brittle, and may have to be placed by hand into little open stacks, a process known as " footing." Finally, the windrows are collected into bog ricks by a machine rivalling the " bagger " in size. It consists of a series of crawler-track-mounted automatic elevators—one per windrow—with a steel plate conveyor connecting between them, which tips on to the rick. At this stage the water content is about 45 per cent. Finally, sods from the ricks are machine loaded on to railway wagons which take them to the power station, the water content at this stage being about 35 per cent.

Milled Peat

Although milled peat with its higher water content is comparatively more bulky to handle and is a poorer fuel, it offers a significant economic advantage over sod peat. This is because the process is completely mechanised at all stages and is thus slightly less dependent on weather than the sod peat process, and also because the production cycle is much faster and production at a new bog starts sooner, so less capital is tied up in the process. Furthermore, the machines used are generally less complicated and cumbersome than the sod peat machines.

The preliminary stages of drainage and preparation are similar to those already described, except that, since only the top surface is worked and not the full depth of the bog, drainage can proceed simultaneously with harvesting, after initially draining the top 2ft or 3ft. The milled peat bog is laid out in 50ft wide fields, separated by drains, and thus the main drains are more closely spaced than for sod peat—another advantage.

The first machine to work on the prepared surface is the milling machine—a half-track tractor equipped with a milling drum. The latter extends the full width of the tractor and is 12¾in in diameter. Spikes are fitted all over the circumference of the drum, and it is rotated at about 350 r.p.m., the spikes penetrating into, and thus disintegrating, a depth of about ½in of the surface of the bog. These machines travel at 5 m.p.h. as they work across the bog. There is also an " offset miller " which cuts a camber along the sides of the field drains, to assist the run-off of surface water.

The milled particles of peat will dry out to about 75 to 80 per cent water content. Then harrows are used to turn the milled peat over and arrange it in little ridges and furrows at about 6in centres ; this is probably the major drying operation. Next a ridging machine is used. This machine is like an angledozer or a grader, its long light-alloy blade pushing the peat in one 50ft " field " into a single ridge in the centre. At this stage the water content is 55 to 60 per cent.

Then the harvesting machine collects the " ridges " of milled peat into bog piles. It consists of opposed conically-shaped screw collectors which sweep the peat on to a belt conveyor, whence it is conveyed and elevated by the chute. The " span " of the machine is 50ft, so the peat is transferred from one ridge to the next. This is done successively over about five " fields " to a position where the bog railway is situated, and the bog pile is left beside the railway, for loading by machine later at a moisture content of 50 to 55 per cent, and transport to the power station or briquetting plant.

The harvesting cycle as described above, from the stage of milling to forming the bog piles, is completed in about three days. With sod peat only two harvests per year are taken off the bog, but with this short three-day cycle, the process is clearly more flexible.

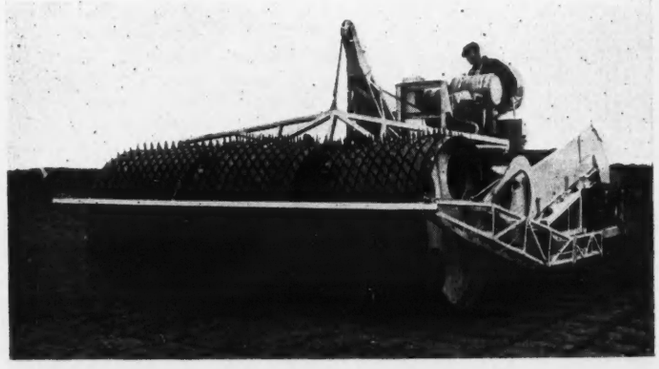
Briquetting Plant

At the group of bogs at Timahoe and Ballydermot sod peat is won for consumption at Allenwood power station. However, in one area milled peat is harvested for use in the briquetting plant at Lullymore, where 50,000 tons of briquettes are made each year. The briquettes are a relatively high grade fuel, smokeless and in many ways convenient for domestic use, with a moisture content of about 10 per cent and a calorific value of 8000 B.Th.U. per pound. Some effort has been put into marketing, and the Board is constructing two further plants, both in Co. Offaly, which will each have an output of 100,000 tons of briquettes per annum.

Milled peat of consistent quality and moisture content is necessary for making briquettes, so the plant has a blending bunker in which milled peat from the bog is spread in horizontal layers in the bunker, the capacity of which is 500 tons, and extracted by rakes which detach substantially vertical layers.

The blended peat is elevated to hammer mills, the tailings of which are screened off and fed to the boiler of the plant. The boiler supplies a turbo-alternator set of 1000kW capacity, and steam is taken from the turbine exhaust at 275 deg. Fah. and 40 lb per square inch, for the process work involved in making the briquettes.

The peat then passes to fine mills, which reduce the particles to approximately ⅛in diameter. It is then blown by fans through a series of drying columns, which are jacketed and heated by steam or hot water. The flow through the columns is somewhat complex, involving a cyclone after each column or stage (four cyclones in all) which rejects and recirculates the lighter (i.e. wetter) fraction. The first stage only uses hot water, which is heated by the condensate extracted from the peat and also by the process steam, at its final stage, in heat exchangers. The fan circuit on the second stage is a closed one, with a condensate tank for rejecting the water extracted from the peat. Peat rejected by the first-stage cyclone goes to a bunker which feeds into the disintegrators. Blending and recirculating controls are positioned just prior to the presses. The presses finally form the briquettes at a pressure of about 5 tons per square inch. The use of turbine exhaust steam and the way the drying circuits are arranged, afford an interesting example of energy conservation in a process where large quantities of water have to be extracted, for the 50,000 tons production of briquettes needs about 125,000 tons of milled peat.



Harvesting sod peat. (Left) The bagger, showing its 200ft spreader arm in the foreground, and the sods cut by the trailing discs on the left; in the background, the machine is travelling alongside the cut " face " of peat. (Below) the partially dried sods are picked up on the drum of this machine and deposited behind it in a windrow.

Vermiculite: Its Present and Potential Value to Engineers

By DUNCAN A. BLACK, D.R.C.S.T., A.I.M.*

Established uses of vermiculite and its basic composition and structure are reviewed. The uses of a fine stabilised dispersion of this solid in isopropanol as an anti-spatter agent during welding and as a preventative for screw thread seizure are discussed in some detail. The incorporation of vermiculite in steam packings and gaskets is briefly mentioned and finally some current tests on potential uses of dispersions of vermiculite are noted.

THE use of vermiculite as a sound and heat insulator is now fairly standard practice and it is also used as an additive to concrete to give porosity combined with low density. We are concerned here with some new uses which may be of help to the engineering industry.

The vermiculites are micaceous minerals mined chiefly in Montana, S. Carolina, Wyoming and Colorado. They are all hydrous silicates of indefinite composition formed mainly by a substitution alteration in the micaceous minerals biotite and phlogopite.

The unit cell of vermiculite has the approximate composition $(MgFe)_3(AlSi)_4O_{10}(OH)_2 4(H_2O)$.[1] Work by Gruner[2] has shown that vermiculite consists of neutral layers $(MgFe)_3(AlSi)_4O_{10}(OH)_2$ alternating with layers of water molecules.

On heating slowly this water is driven off and the solid layers exfoliate or unfold into curled filaments resembling worms (Latin *vermiculus* meaning little worm). Gruner has also shown that when dehydration is carried out at 750 deg. Cent. the water is driven off and the neutral $(MgFe)_3(AlSi)_4O_{10}(OH)_2$ layers then come together to form the talc structure. When heated below this temperature, however, it appears that, on cooling, water is readsorbed and the exfoliation cycle can be repeated almost indefinitely. This would account for some of the properties to be discussed later.

Anti-Spatter Agent During Welding

The degree of spatter encountered in any welding operation is a function of many variables, including section thickness of metal being welded, type of welding being used, and composition of the alloy being welded. In the shielded arc process other factors having a bearing on the amount of spatter produced are current, length of arc and the inert gas being used as the shield. It is characteristic of the CO_2 shielded arc welding process that the electrode holder and gas nozzle readily become fouled with spatter, thus causing turbulent flow in the gas stream. Water-cooled nozzles have to some extent prevented this build up of spatter, but the problem has by no means been completely solved and this has prevented the more rapid and extensive adoption of this process. CO_2 being so much cheaper than argon, the speedy solution of this problem is of vital interest to those industries—principally shipbuilding and boiler making—using the shielded arc process on a large scale.

On welded parts which are not to be subsequently machined or ground, spatter is always objectionable even if only from the point of view of appearance. An important metallurgical effect must also be considered, for when massive sections are welded, white hot spatter landing on the comparatively cold steel may cause hair-line cracking round the spot where the blob of spatter has landed. The degree to which this takes place depends upon the hardenability of the steel, but if the section is sufficiently heavy not to conduct heat rapidly from the heat-affected zone of the weld, then it can happen even in " S " quality mild steel. Such hair-line cracks can act as roots for subsequent fatigue cracks and cannot be tolerated in such things as welded pressure vessels, boilers and submarine hulls. When it is a practical proposition to preheat the part before welding, this danger is greatly minimised, but even then it is advisable to use some anti-spatter agent to act as a thermal barrier and also prevent adhesion of the spatter to the parent metal.

A common agent used for this purpose is ordinary whitening, sometimes fortified with sodium silicate mixed with water and painted on. One objection to this method is that the adhesion of this paste to the metal is very poor and if the parts are to be subjected to mechanical handling after painting the paste is removed. Another objection is that such a coating suffers from " solvent retention," the solvent in this case being water. The result of this is a coating which appears perfectly dry on the surface but, when the parts are put into a preheating furnace at, say, 350 deg. Cent., the trapped solvent behind the dry skin of the coating vaporises and blows the coating off.

Dispersions of colloidal graphite in volatile carriers such as ethanol or isopropanol have also been used as anti-spatter agents during welding with considerable success. There is always some danger, however, that if such a coating is brought too near to the heated zone, in the case of steel, on cooling troostite or even martensite may be formed and a brittle weld results.

These disadvantages have been overcome by using a dispersion† of vermiculite in isopropanol. The concentrated dispersion can be diluted with almost any industrial solvent, e.g. alcohols, aromatic and chlorinated hydro-carbons, esters and ketones, the degree of dilution depending on such things as the required life of the coating, temperature of the spatter and distance of the protected surface from the source of spatter. The dispersion should not be diluted below a ratio of one part to three parts of diluent. Provided the surface of the metal has been degreased, coatings applied by brush or spray will quickly dry and the part can be put into the preheating furnace almost immediately, since the coating does not suffer from solvent retention.

In Fig. 1 there is shown two pieces of mild steel plate welded together. One was coated with a dispersion of vermiculite in isopropanol while the other was left untreated. Spatter has adhered quite firmly to the untreated plate while it has simply bounced off the plate treated with the vermiculite dispersion.

Fig. 1—Specimen of welded mild steel plate; the piece on the right was coated with an anti-spatter solution consisting of a dispersion of vermiculite in isopropanol

An interesting application of this dispersion as an anti-spatter agent has been in the fabrication of " Tru-Weld " mild steel seamless tubes, which have been used to replace forged stanchions and solid rails in the engine and pump room of ships. In this application the jigs, ballasters and tube ends are coated with the dispersion before welding to prevent adhesion of spatter and render subsequent grinding unnecessary.

Prevention of Screw Thread Seizure

The seizure of nuts and bolts on steam turbines, gas jet engines or other equipment subjected to high temperatures and pressures inevitably leads to much wasted time spent on chiselling or burning off the seized parts. When close tolerance fine threads are used, seizure can take place during assembly and

Fig. 2—Vermiculite was for the treatment of the Nimonic nuts and bolts on this assembly, used for suspending large forgings (up to 32 tons) in a heat treatment furnace

* Acheson Colloids, Ltd.

† Product reference 1299 manufactured by Acheson Colloids, Ltd.

may result in serious damage to large and costly studs and nuts. Molybdenum disulphide in various carrier liquids has proved most effective for prevention of this kind of seizure. The other most important cause of screw thread seizure is high temperature combined with corrosive conditions. The probability of seizure is inversely proportional to the difference in coefficients of expansion of the metals from which the nut and bolt are made. Offsetting the benefit to be derived from a large difference in coefficients, however, is the fact that ingress of corrosive gases between the threads can lead to seizure resulting from a build up of oxides or other metallic salts.

Up to temperatures of 560 deg. Cent. approximately, molybdenum disulphide products have proved most effective in preventing such seizure ; graphite products can be used for the same purpose up to 800 deg. Cent. approximately Both solid lubricants prevent metal to metal contact and greatly reduce friction during assembly. These products fail above the temperatures stated because of oxidation, molybdenum disulphide being converted to molybdenum trioxide with no basal cleavage planes to facilitate sliding, and graphite to carbon dioxide.

The effectiveness of vermiculite in a high-temperature application was demonstrated with Nimonic nuts and bolts on tackle used for suspending large forgings in a heat-treatment furnace. Before vermiculite was used, when the tackle had to be dismantled for overhaul, the nuts and bolts had to be burned off and replaced by expensive new ones. The bolts were made from Nimonic 75 having a coefficient of expansion of $15{\cdot}4\times10^{-6}$ per deg. Cent. and the nuts from Nimonic DS having a coefficient of expansion of $16{\cdot}5\times10^{-6}$ per deg. Cent. After the introduction of vermiculite the tackle was used for the following five heat-treatment cycles:

Normalising, 900 deg. Cent.	Tempering, 600 deg. Cent.	Furnace cooling
hours	hours	hours
45	52	111
48½	53	104
49	57	131
36	45	89
37	37	75
215½	244	510

After this the tackle had to be dismantled for repair, due to cracking, and the nuts were unscrewed by hand, despite the fact that they had been subjected to a load of up to 20 tons during this time. The reason for the effectiveness of vermiculite in this application is probably threefold (*a*) its relative chemical inertness reduces the risk of chemical action; (*b*) being highly refractory it continues to prevent metal to metal contact even at such elevated temperatures, and (*c*) even if, as already stated, it reverts to the talc structure above 750 deg. Cent., this structure still provides basal cleavage planes which slip during dismantling.

Incorporation in Packing

Colloidal graphite dispersed in either oil or water has long been used as a lubricating and parting agent in asbestos steam gland packings and cylinder-head gaskets. Under certain conditions austenitic steels in contact with graphite and steam are liable to be affected by pitting caused by electrolytic action. The replacement of graphite by vermiculite has overcome this problem, although vermiculite is not an efficient lubricant and it will not preserve the life of moving parts as does graphite. For such applications as the coating of gaskets, however, vermiculite has the advantage of being more temperature resistant and is cleaner to handle.

Potential Uses

These dispersions of vermiculite are comparatively new and their lubricating value in other industrial processes has yet to be assessed. Apart from the other applications already mentioned, as die lubricants in the hot metal working industries dispersions of vermiculite have the advantages of low price, high-temperature resistance and light colour, although they do not possess the low friction characteristics of graphite or molybdenum disulphide. Very good results have been reported from the use of an aqueous dispersion of vermiculite (vermiculite in water) as a die dressing in the pressure die casting of magnesium. The combination of light colour and good heat insulation suggests that vermiculite may find many applications in the die casting industry where these properties are particularly required.

For the lubrication of rubbing surfaces operating under temperatures from ambient to 850 deg. Cent., graphite or molybdenum disulphide is unsuitable. There is evidence to suggest that a dispersion of vermiculite containing a small percentage of colloidal glass as a binding agent will lubricate efficiently within this temperature range if it is applied as a dry film and baked at 1000 deg. Cent. Vermiculite shows the high electrical resistance of all the mica group of minerals and the possibility of using it as an insulating layer between nickel iron electrical laminations is now being investigated.

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Reclamation of Black Bush Polder

Here we abstract from the paper "The Reclamation and Irrigation of Black Bush Polder in British Guiana," by Messrs. P. A. Scott, R. F. Camacho† and F. A. Sharman,* which was presented for discussion on Wednesday at the Institution of Civil Engineers' conference on civil engineering problems overseas. Details of the engineering design of the scheme are not included here, interesting though they are, for the abstract concentrates on the generalities behind the development, which are of even wider interest.*

THE Black Bush Polder shown in the illustration is an area of 27,000 acres in the low-lying coastlands of British Guiana. Before 1958 it was undrained and uncultivated ; by September, 1959, the work of reclaiming and providing an irrigation system for the whole area was 65 per cent complete. The conversion of this marsh into habitable and productive land involves 8,500,000 cubic yards of excavation and embankment placing, the construction of a pumping station, eight control structures, 22 miles of all-weather road, and seventy-four road bridges. The works will provide a 15-acre rice plot and a 2½-acre area for a house and smallholding for each of 1500 families. The irrigation water supply and the drainage system are designed to secure agricultural production at an economic level every year for the settlers, in spite of the climatic variables which would otherwise cause disastrous losses in years of exceptionally high and low rainfall.

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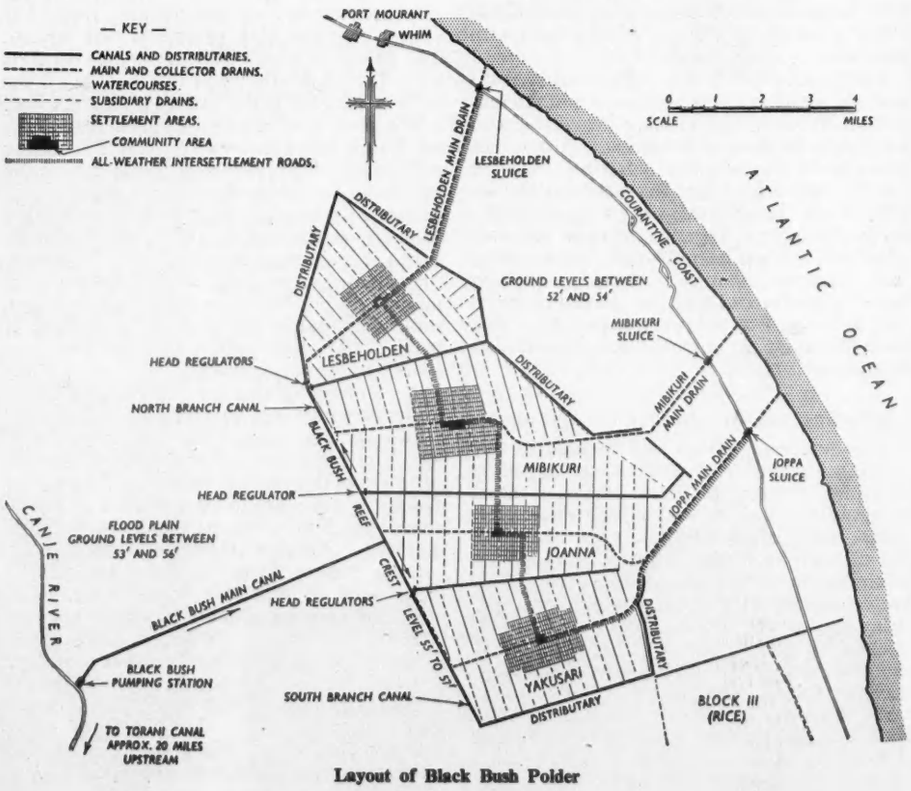
†Director of Drainage and Irrigation, Government of British Guiana.



Layout of Black Bush Polder

Half a million people now live in British Guiana. It is one of those places in which the triumphs of medicine have intensified the problems of absorbing population growth. In 1917, there were only 150,000 inhabitants, and up to 1945 the rate of growth was not more than 1·5 per cent per annum. Then the virtual elimination of malaria changed the health situation radically, and population is now growing at no less than 3 per cent per annum. The people are mainly of East Indian and African origin. Agriculture is their principal economic activity ; more than half of them get their living from the soil, and two-thirds of the value of British Guiana's exports is derived from sugar and rice production. But reasonable opportunities for farming or agricultural development have not kept pace with the rapid growth of the labour force. Unemployment, at 18 to 20 per cent, restricts the growth of general prosperity, and is a political, as well as an economic, problem of great urgency.

Under these conditions there is an ever-increasing demand for agricultural land. In particular, the need is for new farms on which a family can grow their own food and also cultivate a cash crop. Rice is the only established product which has proper marketing facilities, and which can be grown by a peasant farmer with very little initial capital outlay. The investment needed to establish citrus or cocoa plantations is simply not available on the scale required. Sugar production has been greatly increased, and is likely to be increased even further, within the limit of marketing possibilities, but this is being done by improving cultivation, without absorbing significantly more labour or land. Rice expansion is therefore the main trend, although it is the intention to diversify crops as far as possible.

Out of the total area of British Guiana, which is nearly equal to that of Great Britain, only the coastal strip and a few isolated pockets inland offer possibilities for agricultural development. The rest is so covered with thick tropical forest (84 per cent) or is so poor in soil, that the difficult task of providing access is only likely to be undertaken in the quest for timber or minerals. The early settlers took narrow strips of well-drained land, which could be cleared, on the banks of the rivers at various distances inland. The farms they made there did not survive, for under the methods of cultivation they used, the soils quickly became exhausted. These and some pockets of richer soil in the uplands are being surveyed for their agricultural potential, but some of the most promising are within areas declared as Amerindian reserves, and communications in the interior are so inherently difficult that early development on a large scale is not likely in the immediate future.

On the other hand, much of the coastal strip has great agricultural possibilities. It consists of low-lying clayey ground, separated from the sea by a chain of sand reefs, and backed by slightly higher, sandier soils. Almost all British Guiana's crops are at present produced in this plain, yet less than 10 per cent of its 3,800,000 acres is under cultivation. Generally speaking, the soil is fertile, apart from some areas of " pegasse," but unless artificial drainage and sea-defence works are provided, it is subject to flooding from the rivers, from the sea, and from heavy rainfall on the area itself. Channels, dams, and sluices have gradually been built up to control water on the sugar estates, farms, and rice plantations, which generally extend 2 to 4 miles inland (the " frontlands ") from the coastal road. Behind this system lie large areas of fertile soil, sometimes flooded and used as a supply of irrigation water for the frontlands, and sometimes forming rough grazing for herds of cattle, which, in these parts, become almost amphibious.

The conversion of these " backlands " into reliable rice-producing areas is bound to involve large-scale engineering works, planned for a whole region at a time. The Government is obliged to obtain loan or aid fund capital, for which there are many competing claims, for such works, and it must be demonstrated that the resulting increase in productive capacity is commensurate with the investment. Evaluation of total benefit is difficult, but one rough yardstick sometimes used by economists, is that capital expenditure on reclamation and irrigation equal to five times the annual crop value can be justified in British Guiana. At a yield of fifteen bags of paddy, each of 150 lb per acre, sold at 6·8 B.W.I. dollars, something over 500 dollars per acre would be indicated for the Black Bush Polder area. On the other hand, a detailed forecast of a farmer's probable annual balance sheet in these lands, suggests that a considerably higher expenditure on reclamation and irrigation would still show a favourable return.

The Black Bush Polder

The Canje River, flowing parallel to the sea coast about 15 miles inland, is a potential source of irrigation water for a large part of the Courantyne Coast. " Frontland " cultivation, extending 4 miles inland from the coast road, has hitherto been protected from inland floods, and supplied with water, by the construction of a continuous low embankment—the " Crown dam "—which trapped rainfall between itself and the Black Bush line of sand reefs which form the watershed between the Canje and coastal catchments. The trapped water lay in shallow conservancies on the flat, marshy ground, whence it was admitted to the irrigation channels of the frontlands. Besides rendering large areas useless for anything but unreliable rough grazing, these conservancies were subject to high evaporation losses, and were apt to be dry when most needed. Frontland rice yields were severely affected in dry years, but in normal years the supply worked reasonably well.

The Canje catchment is not large enough to secure irrigation water for all the fertile areas worth draining and clearing. The Berbice (which runs further inland to a common delta) on the other hand, has water to spare, and though the levels of both rivers fluctuate with the tide, it is possible to induce an average of 845 cusecs to flow under gravity from the Berbice to the Canje, via the Torani Canal, completed in 1957, to sustain irrigation of the " Block III " and Black Bush areas, while leaving enough water for a reasonable expansion in sugar-cane cultivation on the Courantyne coast. The amount of water available via Torani set the limit to the area to be reclaimed under the schemes. The Black Bush Polder area is the last development of Canje water at present available ; its 27,000 acres will leave just enough surplus to make up for the loss of conservancy water to the frontlands, and it fits neatly between developed land on three sites, and the watershed of Black Bush reef on the fourth.

All the soil of the Polder area is suitable for rice growing. Before drainage began it was waterlogged much of the year, and vegetation varied from thick bush with many trees, to open grasslands. The watershed sand reefs are quite heavily wooded, mostly by bulletwood trees, which looked like useful timber but proved to be a disappointment. The " watershed reef " is only 2ft or 3ft above the general level of the Polder area, i.e. the reef crest is at about 56ft or 57ft above datum ; general ground level is from 52ft to 54ft, and the tidal range of the sea coast is from 55ft to 44ft. Large drainage channels through the frontlands are therefore needed to get water from the Polder to the sea with minimum head loss, and sluices are required at the sea-defence line to discharge the outflow at middle and low tide, and to stop sea-water from flowing up the drains at high tide.

Annual rainfall in this area averages between 90in and 100in, but varies widely. The total amount falling in a rice-growing season (April to October) is more often than not likely to be less than the crop requirement, and even when there is enough, it may fall at the wrong periods for good fallowing, planting, growing, and harvesting in plots of more than a few acres. Rainfall intensities of 5in in five hours, or 8in in twenty-four hours, have to be allowed for.

The object of the Black Bush Polder project is to provide each of 1500 families with a house plot in 2½ acres, and a 15-acre rice field, all on newly-drained and irrigated land between Black Bush reef and the Crown dam.

During rainstorms, water must, to some extent, accumulate on the fields in this type of country. Drainage, however, must be sufficient to avoid " drowning " the rice plants by covering them too deeply for too long. An extra 4in of water can be tolerated for short periods, if the plants are sturdy enough, but during the early stages of growth, 2in extra is the maximum, although the probability of prolonged heavy rain is less at such times. Rainfall record analysis, and experience, both indicate that if 1½in every twenty-four hours can be drawn off, the crop should be secure against all but the most exceptional combinations of rainfall intensity. This figure was adopted in the design.

The calculation of irrigation water requirements is more complex. Rice needs 8in of water on its growing area each month to allow for growth, evaporation, and transpiration, and an additional 6in around planting time. The aim is to supply the 6in exactly when it is wanted, and the difference between the actual rainfall on the fields and the required 8in each month. Records show each month of the year to have a characteristic probability of showing any given deficiency, but the phenomenon of persistence, i.e. a tendency for wet and dry months to group together, to give exceptionally wet or dry seasons, has to be reckoned with. A supply of 1000 cubic feet per acre per day for the 15-acre rice plots, and 400 cubic feet per acre per day for the 2½-acre holdings, allows for the maximum rate of distribution ever required.

If each house were built on its own 15-acre rice plot, the community would be far too scattered, and an enormous mileage of roads would be needed, yet a farmer ought not to live too far from his work. The compromise arrived at between these two considerations was to plan the houses in four settlement areas, each of which is to have all-weather road access and a community centre, and to be made up of 300 to 500 2½-acre holdings, each containing its house, garden and, small-holding. The settlement areas are roughly in the centre of an area containing as many 15-acre plots as there are houses in the settlement—on this plan no house is more than 3 miles from its own rice field. Even if little capital is available for mechanisation, a farmer should be able to cultivate the rice field and the house-holding under this system. It is hoped that the settlers will purchase and operate farm equipment on a co-operative

basis, and it is the Government's intention to encourage such enterprise.

As for transport, it was assumed that an all-weather motor-road was essential to give access to the settlement housing areas. The cost of bringing such a road to all the fields would have been excessive, but the irrigation network was, in any case, bound to provide navigable channels to every part of the area. The plan was therefore based on water transport for the rice harvest, with fair-weather roads on the drain embankments to allow men, beasts, and tractors to travel between the settlement-housing areas and the fields.

The new rice fields should produce about 25,000 tons of paddy per year, to be milled to give about 17,500 tons of rice. Milling capacity in the Courantyne area will obviously have to be increased to deal with this, and the nearer the new mill, or mills, are to the fields, the cheaper transport and handling can be made. A scheme was worked out for building a large new mill on the Canje, beside the pumping station, at the end of the main canal which feeds the irrigation system. Paddy would come to this mill in barges from collecting centres sited on the distributaries, and rice would be loaded directly on to ships from Georgetown and the West Indies—the main market. Such a mill, with its system of collecting centres, tugs, barges, and ships, would involve a capital expenditure of several million B.W.I. dollars, but would produce high-quality rice for export at maximum efficiency. The difficulty of raising the necessary capital, and the desire of local millers to erect their own smaller mills, has so far prevented the adoption of the central mill scheme, and other arrangements may have to be devised.

The British Guiana Drainage and Irrigation Departments consulting engineers for the scheme are Sir William Halcrow and Partners; the main contractor is Pauling and Co. (Overseas), Ltd.

Automatic Heat Treatment Installation

A completely automatic heat-treatment line for tapered roller bearing cups and cones has been designed and installed at a British Timken works by A.E.I.-Birlec, Ltd. In a linked series of four furnaces the components are carburised, annealed, hardened and tempered under precisely controlled conditions at a rate of about 500lb per hour.

AN automatic heat-treatment line in which a sequence of carburising, sub-critical annealing, hardening and tempering is carried out in furnaces linked by mechanical and hydraulically-operated devices has been installed in the Daventry works of British Timken, Division of the Timken Roller Bearing Company, by A.E.I.-Birlec, Ltd., Edington, Birmingham. This equipment has been developed and installed primarily for the heat-treatment of tapered roller bearing cups and cones being supplied in connection with the vacuum brake rolling stock required under British Railways modernisation scheme. Our illustrations show some parts of the installation.

The cups and cones are first cleaned in a washing machine from which they pass to a loading station where an operator places them on locating fixtures made of cast nickel chromium alloy. These loaded fixtures are assembled, four at a time, in nickel chromium trays and three of these trays form a furnace charge at each loading sequence. From this stage onwards the complete heat-treatment cycle is automatic and no further manual operations are involved until the parts are unloaded on emerging from the tempering furnace.

At the beginning of the line three loaded trays simultaneously enter the vestibule of a continuous carburising furnace which has a capacity for about 500lb per hour and is heated by gas-fired radiant tubes arranged in four zones. Each zone is under independent and automatic temperature control, the first being a heating zone, 31ft 6in long, the middle two soaking zones, and the fourth a diffusion zone. A controlled carburising atmosphere is supplied to the furnace by a Birlec endothermic generating plant and propane enrichment of the atmosphere is regulated by a Foxboro-Yoxall dewpoint controller.

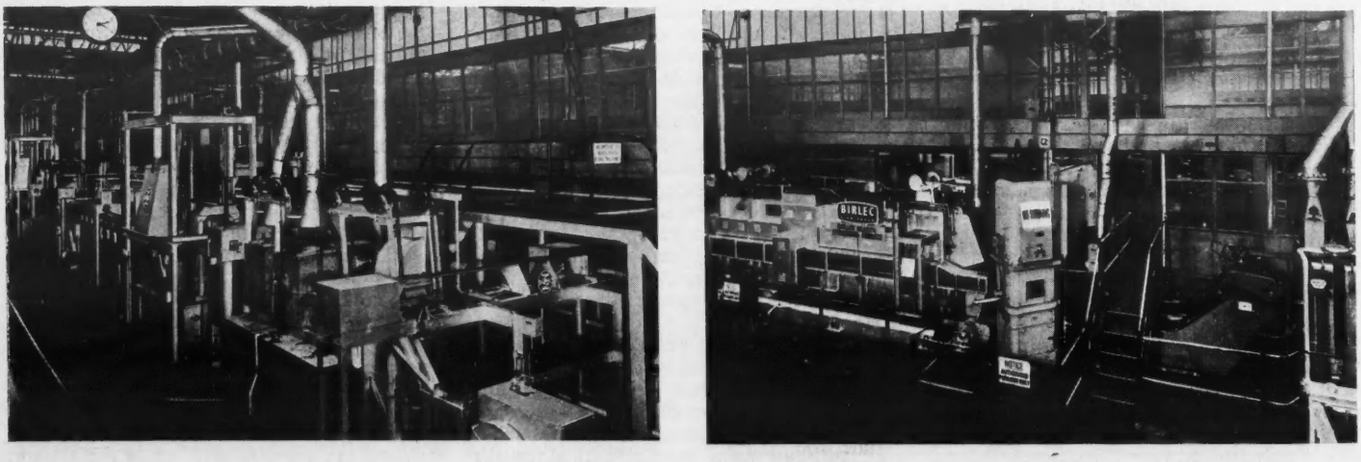
The trayloads of bearing cups and cones are supported along a triple track in the furnace and they are moved through the furnace by a sequence of synchronised pushes from hydraulic cylinder mechanisms located at the charge end of the furnace. Whilst, at present, identical time cycles operate on the three tracks, appropriate sequence equipment has been incorporated to enable different time cycles to be used on the individual tracks.

At the discharge end of the furnace, a hydraulic pusher moves one tray at a time in sequence from the three tracks on to a platform, which is then lowered automatically into an oil tank to quench the charge. Each loaded tray is then carried by a chain conveyor through a washing station for spray washing and hot water rinsing. The work trays are then transferred automatically to the loading mechanism of the sub-critical annealing furnace.

An electrically-heated pusher furnace, rated at 145kW, which is used for annealing, is heated by wall-mounted tape elements arranged in three zones. An exothermic generating plant supplies a protective atmosphere to the heating chamber of this furnace. After annealing, the trays are discharged singly from the furnace and quenched, washed, rinsed and dried in a similar manner to that employed for carburising.

At this stage in the heat-treatment cycle, the components are " de-stacked " from the tray and delivered on to conveyors leading to the hardening furnace. This "de-stacking" operation is performed by two sets of air-operated fingers, projecting from an overhead trolley, which lift the stacks of cups and cones off the tray fixtures, and release them in pairs on the conveyors. In the second stage of this operation, the turntable on which each tray is supported in turn is rotated through 180 deg. and the empty tray and fixtures returned to the charge end of the carburising furnace by a chain-driven pusher and conveyor.

The components are transferred to a roller hearth furnace for hardening by conveyors from which the parts are deposited on to the furnace track by a twin lever mechanism synchronised with the opening of the charging door. The 18ft long heating chamber, is electrically heated by nickel chromium alloy tape elements in the roof and by cast grids in the hearth. There are two heating zones in the furnace, with a total rating of 120kW, and each component completes the hardening cycle in approximately an hour. This fur-



Part of the continuous heat treatment line for bearing cups and cones, showing in the foreground, on the left, the annealing furnace. On the right can be seen the roller hearth hardening furnace

nace is provided with an atmosphere from an endothermic generating plant similar to that feeding the carburising furnace.

The rollers forming the hearth of the furnace are arranged in a number of sections, each of which is individually driven from a main shaft running along one side of the furnace. At the discharge end of the furnace, the last section of rollers is fitted with an overdrive to give fast discharge. Two photo-cell units control the operation of the fast roller drive gear and the discharge door. On completion of the necessary soaking time in the hardening furnace, the discharge door is opened to allow a pair of components, as detected by the photo-cell, to be discharged by the fast rollers.

On leaving the furnace, the components are turned by deflecting ploughs through 45 deg. to a pair of jig quenching machines. In these machines pneumatic devices position the components against adjustable stops on the quench plates and during controlled quenches effected by the operation of air-hydraulic rams jig plugs locate in the bores to minimise distortion. The components are discharged along chutes and conveyors to a further washing machine.

After washing the cups and cones are aligned in a mechanised handling device which feeds them across the width of a continuous tempering furnace. This device positions the cones inside the cups before they enter the furnace. Tempering is carried out in a continuous slat conveyor furnace rated at 48kW and having a 15ft long chamber which is heated by special electric elements fitted in the side walls and arranged in two zones. Components travel through this furnace on a series of steel slats supported by driven roller chains. To promote convection heating the slats are perforated and a vigorous air flow through the load is maintained by four fans in the chamber roof. At the discharge end of this furnace, cups and cones are separated by another handling unit which deposits into two separate chutes. From these chutes the components are fed on to two wire mesh belt conveyors to stacker storage units similar to those proceeding the heat-treatment line.

By the correct selection of quenching operations with this continuous installation of atmosphere furnaces, it has been possible to minimise the formation of scale on components during heat-treatment; no shot-blasting or final degreasing of components being required.

The supply of quenching oil to the three quenches in this installation, as well as to the roller heat-treatment installation, is obtained from an oil service house where three 6000 gallon capacity oil tanks and multiple pumping sets are installed. Thermostatically controlled coolers mounted on the oil house roof maintain the correct oil temperature.

Throughout the whole of this installation and the roller heat-treatment installation, fumes and waste gases are extracted by a system of exhaust trunking supplied by the Modern Air Company of Leicester. This trunking couples all points of fumes and gas escapement in the installation to a common junction extending through the wall of the factory, and thence to an extractor fan on the roof of the oil service house.

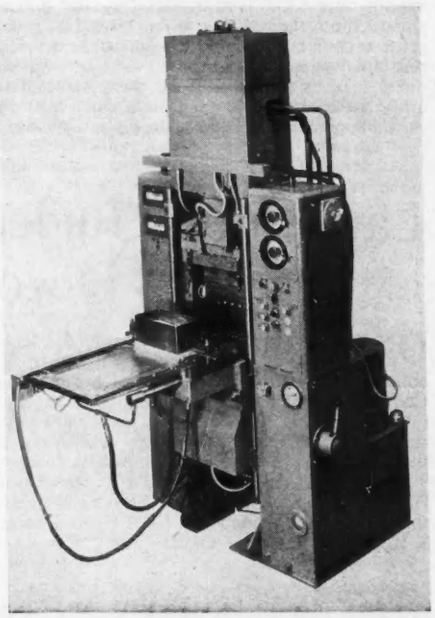
Plastics Moulding Equipment

TO provide the plastics industry with a vertical locking press capable of high production rates in the processing of thermoplastics a range of injection units has been developed by B.I.P. Engineering, Ltd., Streetly, Staffs., for direct coupling to the firm's compression presses. One of these new units of 32 oz capacity coupled to a 600-ton press and operating in timed relationship to its working cycle can be seen in one of the illustrations we reproduce.

The injector has a heavy gauge welded steel plate base incorporating the hydraulic fluid tank, pump and controlling valve gear. The injection assembly is mounted on precision slides on this base along which it can be advanced by hydraulic power to position the heating chamber against the mould. When the chamber registers against a precision lapped sealing surface on the mould the assembly is secured in position by high-tensile tie rods. The injection assembly includes a hydraulic power cylinder, material hopper, feed block and the plasticising chamber. The three basic components of the plasticising chamber are a spreader, heating cylinder and feed cylinder.

The spreader is made in one piece with the front cap and its surfaces which come into contact with the thermoplastic material are fluted to give the maximum heat transfer. Each individual flute decreases in depth towards the front of the chamber to present a diminishing cross-sectional area with a resultant skin purging of the thermoplastic material. In addition to the usual heating elements round the plasticising chamber a number of heating elements are contained in bores within the spreader and its temperature is closely controlled by a thermocouple unit. With the large heating surface area provided by this design the chamber plasticising capacity is large for its size. By removal of the tie rods and retraction of the main assembly the plasticising chamber can be easily taken down for cleaning.

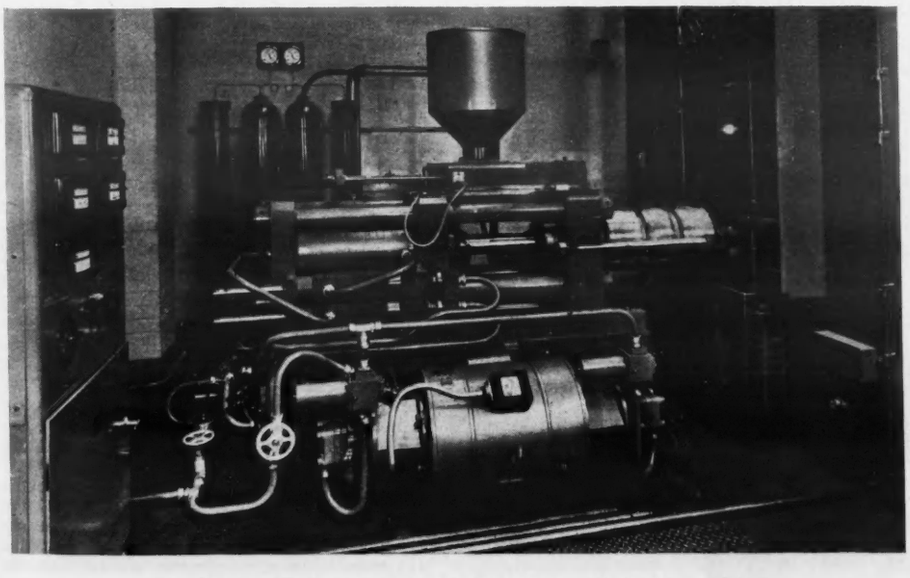
The connection of the horizontally disposed injection unit to a press is designed to give a minimum of thermoplastic "hang-back" during operation. For this purpose the bed of the press has fitted on it a specially designed delivery tube which carries the heated material to a "goose-neck" block leading to a standard injection nozzle. This attachment is arranged within a support plate of the standard platen size and the injection nozzle is situated on the centre line of the platen, through which it protrudes. The bottom mould attachment platen is seated on top of the support plate provided with a standard pattern of tapped holes for mould mounting. This mould attachment platen is secured to the bottom ejector gear so that the platen has a controlled vertical movement giving free access to the injection nozzle. An adjusting device giving a vertical nozzle adjustment of up to ¼in is incorporated between the nozzle and moulding sprue bush to enable final pressure setting.



20-ton fully-automatic compression press

The control equipment cabinet houses controlling and indicating pyrometers, which enable four or five individual zones of temperature control, and time cycle controllers for individual setting of dies closed and injection ram forward operation periods. In addition to the usual double-shot and pre-pack controls there is also provided an injection ram pressure control movement. With this control the injection plunger can be advanced under high pressure at high speed for a predetermined time or distance, then—for the final injection squeeze—the ram is advanced at a pre-set lower pressure. With this control the final supply of thermoplastic material is delivered effectively but at a pressure which will not strain the mould or give undue flash-out. It compensates for variations in material feed and ensures that the final controlled pressure stroke is always the same length.

Our second illustration shows a new 20-ton fully automatic downstroking hydraulic compression moulding press recently introduced as an addition to the 60-ton, 80-ton and 150-ton automatic presses made by the firm. This press is



32 oz/600-ton dual-purpose press with the injection unit for thermoplastics

self-contained with a 5 h.p. motor-driven Vickers pump, delivery fluid at 1000 lb per square inch, and incorporating all the necessary valve gear. Its main locking ram force is 20 tons and the pull-back force is 2 tons, the main ram stroke being 10in. The table tool area is 7in by 12in and the maximum available daylight between tables is 22in. The top and bottom tables are fitted with mechanically locked, twin hydraulic ejector equipment giving an operating thrust of 1½ tons. A fully automatic powder loading and mould stripping gear provided as a complete unit pivoted on the front of the press is locked in position when required but can be swung clear for hand operation of the machine when necessary or to give full access to the tooling. A " Bipel " 1-gallon air/hydraulic piston accumulator enables automatic pump unloading to be effected and provides energy for rapid press operation.

The automatic powder loading unit and stripping plate are mounted together on a ram-operated slide at the front of the press and their operation is locked with the automatic cycle of the machine. At the end of a moulding cycle when the ram has retracted and the mouldings ejected from the bottom die the slide moves forward into the machine. The hinged stripping plate at the front of the slide rests on the die plate and slots cut in its leading end pass it through the raised ejector pins which are then retracted to leave the mouldings on the plate when it stops. As the forward movement takes place the loading cavities in the plate behind the stripper pass under the moulding powder box and are filled. The slide then moves forward again to position the loading cavities over the die impressions and this movement carries the stripper plate out of the rear of the tool. In this position the stripper plate is free to hinge downwards under its own weight and deposit the mouldings into a bin. The loading slide then withdraws to its fullest extent and the press moulding cycle begins.

When top instead of bottom ejection, as described above, is required alternative methods can be adopted. In one method a curved comb plate slotted to clear the top ejector pins is attached at right angles to the rear of a deep sided tray. When this assembly has moved in its first step into the die opening the top ejector pins descend to free the mouldings, which drop into the tray. When the slide then moves forward into the cavity loading position the comb plate at the rear of the tray sweeps across the top tool to loosen any mouldings which have failed to leave the ejector pins and deposits them into the tray. At the end of this movement the tray tips and deposits the mouldings into a bin as before.

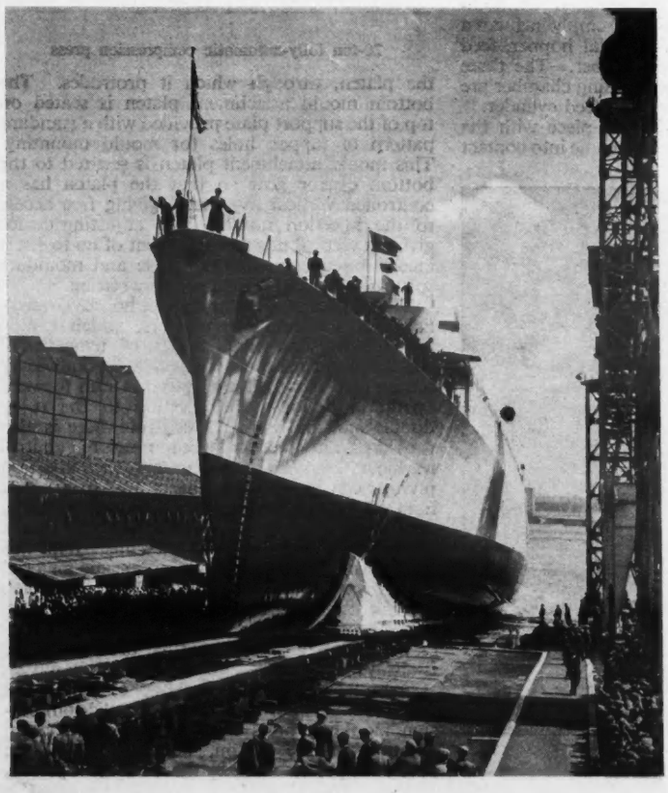
The press has a fully sequenced cycle and also is provided with means for one tool " breathing " movement which is controlled by a timing clock. A second timing clock determines the period of curing. Either manual or automatic cycling can be determined by the setting of a switch and any required form of electric die heating can be used on the machine.

Launch of Guided Missile Destroyer " Devonshire "

ON Friday, June 10, the first guided missile destroyer to be designed for the Royal Navy, entered the water from the yard of her builders Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., and our illustration shows the ship about to enter the water. Following a short religious service the ship was named " Devonshire " and then launched by Her Royal Highness Princess Alexandra. This is the eighth ship to bear the name since 1692, the last being a 10,000 ton cruiser. Of the new " County " class of destroyer, of which three more are under construction, the " Devonshire " was laid down in March, 1959. She is expected to be commissioned in the first half of 1962 and will be joined by the remaining three ships of the class, " Hampshire," " Kent " and " London," by the spring of 1963. This class of destroyer has a length of 520ft by 54ft beam, a standard displacement of 5000 tons and carries an armament which includes four radar controlled 4·5in fully-automatic dual-purpose guns in twin mountings placed forward, two " Seacat " ship-to-air close-range guided weapon systems sited abaft the after funnel, and one " Seaslug " ship-to-air guided weapons system mounted on the quarter deck. In addition to underwater detection equipment, a Westland " Wessex " helicopter will be carried, the first of such craft to be fitted as a " hunter killer," for anti-submarine work. Stabilisers will be fitted and these, apart from other uses, will facilitate the take-off and landing of the helicopter. There will be fitted the latest air and surface warning radar associated with electronic plotting equipment, similar to that installed in the aircraft carriers " Victorious " and " Hermes," while the operations soon will be of new design.

Comfortable quarters have been incorporated in the design for the thirty-three officers and 400 ratings who will form the ship's company. Bunks will be fitted in the mess decks and arranged so as to leave the maximum space for recreation and other amenities. Large dining halls have been planned to be served by a galley designed to provide meals on a self-service system. The ship will be air conditioned throughout.

Propulsion is by two shafts powered by a combination of steam and gas turbines, designed by Associated Electrical Industries, Ltd., a system which has been developed as a result of collaboration between the Yarrow-Admiralty Research Department, Associated Electrical Industries, Ltd., and the ship and engine builders. The steam turbines will provide the power required for normal steaming conditions, while the gas turbines will give the additional power necessary for the ship to attain its maximum speed of about 32·5 knots. The gas turbines also enable the destroyer to be under power at short notice and to leave harbour without waiting for steam to be raised and the engines warmed through. With the new system steam can be raised with the ship under way. Each shaft is driven by a set of geared turbines and by a pair of 7500 h.p. gas turbines which are geared to it.



The Royal Navy's first guided missile destroyer, the 5000-ton "Devonshire", leaving the ways on June 10. She is 520ft long by 54ft beam. The propulsion machinery is a combination of steam and gas turbines.

Promoting Knowledge of Electronics

THIS year is the twenty-fifth anniversary of the formation of Ultra Electric (Holdings), Ltd., which occurred in the same year as the opening of a new factory on Western Avenue for the manufacture of radio sets by Ultra Electric, Ltd. Under that name the company dated back to 1925, and had been known previously as Edward E. Rosen and Co., which began producing headphones and loudspeakers in 1920. During the past twenty years the Ultra organisation has extended its activities into the specialised electronics field and in recent years had been operating in two divisions—the Radio and Television Division and the Special Products Division. Activities of the latter division have included simulators, aircraft intercommunication systems, and the Ultra aircraft electric throttle control system described in our May 27 issue. In January of this year two subsidiaries were formed—Ultra Radio and Television, Ltd., and Ultra Electronics, Ltd.—so that the activities of the two divisions could be more effectively organised. A v.h.f. radio paging system for selective calling of up to ninety-eight individuals has just been introduced by the latter company.

To mark this anniversary year, the parent company is sponsoring a programme of lectures designed to be of use and interest to all connected in any way with the future of the electronics and associated industries, and to promote general interest in the activities of the industry. The first lecture will be given on Wednesday, September 14, in the Recital Room of the Royal Festival Hall. The speaker will be Professor Arthur Porter, M.Sc., Ph.D.(Manchester), Dean of Electrical Engineering at the University of Saskatchewan, whose subject will be " The Evolution of Instrumentation." On October 19, also at the Royal Festival Hall, Mr. G. W. A. Dummer, Superintendent of Components Research, Development and Testing at the R.R.E., will review the latest developments in components and the future in this field. Early in November a special programme is to be given for senior students from London schools.

SHORTER REPORTS

Reinforced Concrete Association

THE annual dinner and dance of the Reinforced Concrete Association was held at the Dorchester Hotel last week, on June 8. The principal speaker was Sir Ifor Evans, provost of University College, London. The theme of Sir Ifor's speech centred on his belief that fundamentally the progress of our society to-day largely depended on the work of professional scientists and technologists, rather than on the activities of Government, and he emphasised four essentials of "research, design, integrity and initiative." Turning more specifically to the Association's sphere of interests, he pointed out that this outlook had been reflected in the present appointment of a professor of architecture at University College, who was qualified both as an architect and as an engineer. The Association's President, Mr. C. Blumfield, replied to Sir Ifor's toast, and spoke of the varied activities of the Association during the past twelve months, which included the formation of a new class of membership—that of professional membership—and of progressive work by various technical committees. Mr. W. K. Laing and Mr. Hubert Bennett, architect to the L.C.C., also spoke, and the evening's events included the presentation of a cheque for £500 to Mr. R. V. Chate on his retirement from the post of secretary of the Association. Mr. Chate had been secretary of the Reinforced Concrete Association since it was formed nearly thirty years ago; he is succeeded by Mr. A. B. Harman.

Anglo-Swedish Telephone Cable

THE British Post Office cableship " Monarch " sailed from Southampton on June 7 to begin laying over 500 miles of submarine cable linking the United Kingdom and Sweden. The new cable, which will be the longest single two-way submarine cable laid to date, will come into operation in October. It will have a capacity of sixty telephone circuits and will relieve the Anglo-Dutch cables over which most of the U.K.-Sweden telephone traffic at present passes. At the same time it will provide a direct and more economic routeing of the telephone and telex traffic between the United Kingdom and Sweden, and via Sweden to Finland. Laying of the polythene dielectric coaxial cable and the twenty-eight repeaters began on June 10 and was expected to be completed on June 16. One of the smaller G.P.O. cable ships, " Ariel," has been helping in the work. The cable runs between Gothenburg and Marske, near Middlesbrough. Overall testing and lining-up of the system will be the joint responsibility of the British Post Office and the Royal Swedish Board of Telecommunications. British contractors are Standard Telephones and Cables, Ltd., for the repeaters, submarine cable and the repeater supervisory and terminal equipment; the Telegraph Construction and Maintenance Company, Ltd., for the land cable; and the Westinghouse Brake and Signal Company, Ltd., for the submerged repeater power feeding equipment.

New Aerial System for Somerton

FELLING of twenty-seven steel masts at the G.P.O. radio receiving station at Somerton, near Yeovil, is the first major step towards replacing the existing aerial system. The station was constructed in 1929 and has forty-seven receivers in full use on the reception of overseas radio telegraph traffic ; twelve more will be installed during next year. A considerable reconditioning and replacement programme would have had to be undertaken during the next few years if the 280ft masts were to go on being used with safety. Because of the considerable expense that this would have involved it was decided that a more flexible aerial system of modern design should take the place of the existing aerials, some of which were designed thirty years ago. This would give better service to the station and substantially reduce maintenance costs.

Preliminary work has been in hand for some time and the point has now been reached where it is necessary to replace the existing masts. Each of these weighs 30 tons, and arrangements are being made to pull them over one by one and dismantle them on the ground. The new masts are shorter and more slender than those which they replace, and will blend more easily into the landscape. The new aerial system when completed will employ ninety-three 180ft lightweight stayed masts for supporting the aerials and 510 telegraph poles for carrying the transmission lines from the aerials to the receiving building. A total of 133 miles of wire will be used in constructing the new aerial system. When the programme has been completed about 70 acres of land on the station site will be available for cultivation.

High Bay Lighting Fittings

A NEW range of heavy-duty prismatic lighting fittings is available from Holophane, Ltd., Elverton Street, Westminster, S.W.1., for use in steel works, heavy engineering plant and large assembly shops, and are designed to provide efficient optical light control with 1000W " MB " and " MBF " mercury and mercury/fluorescent discharge lamps. A broad, intensive light distribution enables spacing/height ratios to be adopted which will offer full economic advantage in the use of high-efficiency 1000W discharge lamps having an average output of 45,000 lumens.

A cast metal canopy protecting the lampholder carries four straps supporting a steel cover and ring on which the prismatic reflector is mounted. Convection currents, which have a scavenging effect, are promoted by the open neck, thus reducing temperature rise and maintenance. The top entry is tapped for 1in conduit. Three forms of Holophane heavy-duty prismatic glass reflector can be used with the same basic design of fitting to provide alternative light distribution characteristics from 400W–1000W discharge lamps or 1000W–1500W tungsten filament lamps. Diameter of the fittings is 15¾in, height 17in–19½in, and weight 17lb–18lb.

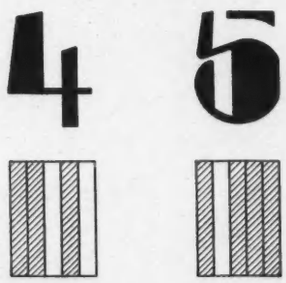
Fitting for high-wattage filament or discharge lamps. Where upward light is not required, the same design is supplied with a steel cover over the prismatic glass reflector

Translucent versions of the range, without the cover over the reflector, are also available for use in aircraft hangars, power stations, factories and erection bays, providing semi-direct distribution of various characteristics according to choice of reflectors, and giving an upward component of light for lofty mounting heights. These fittings, an example of which is illustrated, take 300W–1500W general lighting service and 400W–1000W mercury discharge lamps. Diameters are 12½in–15¾in, heights 14¼in–19¼in, and weights 10lb–15lb. The top entry is tapped for 1in conduit.

[Reply Card No. E10211]

Electronic Figure-Reading

THE first demonstration of automatic cheque handling using the new E.M.I. Figure-Reading Electronic Device (FRED) in conjunction with the Pitney-Bowes/National high-speed document sorter, was given on June 7 at the Hayes headquarters of E.M.I. Electronics, Ltd. FRED has been developed as a numeral reading machine specifically for use with bank cheques and similar business purposes. All the data normally found on a cheque — such as serial number, branch number, customer's identity and amount — can be coded along the bottom edge in numerals designed to break down on being scanned into a simple five-element bar code in which each element is mainly black or mainly white according to its position.



Composition of FRED numerals and corresponding bar codes recognised as " 4 " and " 5 " by the electronic reader

Two of the FRED numerals are illustrated herewith, together with their corresponding bar codes. Mainly black elements in the bar code are shown hatched for clarity, although it will be noted that the figures are solid black, which facilitates printing and also contributes to the easy issual recognition which is a characteristic of the system, the eye being presented with characters conforming closely with those to which it is accustomed in reading print. The form of the numerals, in fact, is similar to the existing " Broadway " type face.

If the numeral five, for example, is imagined to be divided into five equal vertical columns, it will be seen that, reading from right to left, the five elements of the bar code are : (1) mainly black, (2) mainly black, (3) mainly black, (4) mainly white, (5) mainly black. If a " mainly black " column is represented by 1 and a " mainly white " column by 0, the code for 5 is 11101, as for the bar code. Each numeral is coded in this way. As the first digit in each code is always " 1 " — the right-hand column of each character is always black — this form of code gives four variable digits, with sixteen possible combinations. Various other symbols are constructed similarly.

Accurate spacing of characters along a line, or precise positioning of a character relative to the leading edge of a cheque are unnecessary, and normal printing tolerances are sufficient.

[Reply Card No. E10212]

SHORTER REPORTS *(Continued)*

New Lighting for Leeds-Bradford Airport

WITH the completion of its new airfield lighting, Leeds-Bradford airport—the only civil airport in Yorkshire—is now fully operational by night. The lighting system was supplied by The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, and the installation was carried out by N. G. Bailey and Co., Ltd., under the direction of Mr. D. Currie, city engineer of Leeds.

Situated at Yeadon, about 6 miles from each city, the airport is owned and operated jointly by the two city councils. Traffic is expanding rapidly, and in the first quarter of this year the number of passengers handled was nearly three times the corresponding 1959 figure, while freight has more than doubled. Scheduled services are run by four operators to the South of England, Eire, Northern Ireland, and the Continent. The lighting was therefore part of an overall scheme to increase traffic capacity. Resurfacing of the main runway (10-28), which is 3920ft long, was completed in April, 1958, and work on the lighting system was put in hand late last year.

The west approach at Yeadon, showing line and bar system and angle-of-approach indicators at each side of runway lights

The runway has been equipped with bi-directional, high-intensity elevated lights, spaced 200ft apart along each side, equipped with 6·6A, 200W tubular "Osram" lamps. This fitting has an overall height of less than 10½in, which is low enough to miss the propeller blades of aircraft, even with burst tyres on one side, and the mounting has a weak section so that the light can be snapped off on impact. Ten threshold lights at each end of the runway are of the same type but with green colour filters. At the west end the runway extends past the threshold to join a taxi-track as can be seen in the illustration and the threshold lights are therefore installed in two rows of five at each side of the runway instead of across its width.

Both approaches have uni-directional high-intensity white lights and omni-directional low-intensity red lights, laid out on a 1400ft centre-line with one 100ft wide crossbar; at the east end the crossbar is 1000ft from the threshold and at the west end the corresponding distance is 845ft. On the east approach—the one generally used in bad visibility—the high-intensity lights have been duplicated and the pairs of fittings angled slightly apart to give a greater beam spread.

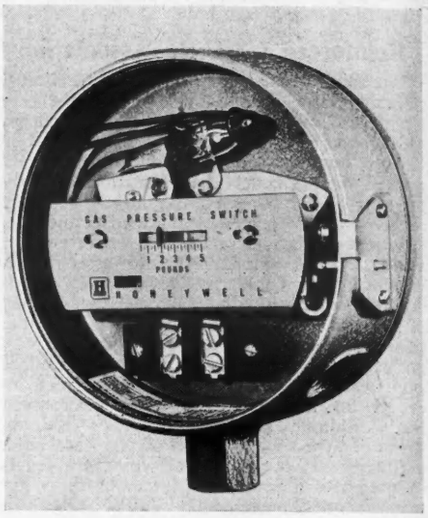
For the most part, the approach lights are mounted on poles which, at the west end, are high enough for the lights to shine clear above the tops of trees and houses, and at the east end are graded in height to counteract the sharp fall-away of the ground. Each approach lighting system also includes a pair of high-intensity angle-of-approach indicators, one on each side of the runway as seen in the illustration. These indicators give a flashing beam of light, divided into red, amber and green zones, indicating respectively to an approaching pilot that he is too low, too high, or on the correct glide path.

All the high-intensity lighting in the runway and approach systems and the angle-of-approach indicators can be controlled separately in five steps of brightness. Low-intensity approach lighting is controlled in three steps. Control of all lighting is excercised from a console with mimic diagram in the control tower, from which a 50V d.c. cable runs to the switch room housing the airfield lighting switchboards.

[Reply Card No. E10221]

Pressure Control Devices

Two additions have been made to the gas pressure control devices of Honeywell Controls, Ltd., Ruislip Road East, Greenford, Middlesex. The gas pressure switch illustrated belongs to the company's range of simple non-indicating industrial controllers, and can be used as a safety cut-off switch or simple pressure controller for both hazardous and non-hazardous gases. The mercury switch is operated by a diaphragm, and a seal-off diaphragm prevents gas from entering the switch chamber should the main diaphragm be ruptured. With non-hazardous gases, the switches can be used as differential pressure controllers since the seal-off chamber becomes the low pressure side. Pressure ranges from ¼in - 5in water to 10 lb-100 lb per square inch are available. Switching action is make or break on pressure rise according to model, and both single-pole and double-pole, single- and double-throw versions are available. A lockout feature, optional on some models and standard on others, prevents recycling after once breaking circuit, when the pressure returns to preset limits. When incorporated, this facility can be adjusted to eliminate lockout if desired.



Gas pressure switch with mercury control element

A second recent Honeywell introduction is the new industrial "Pressuretrol" model P428, designed for general applications requiring control or limiting of gas or liquid pressures up to 3000 lb per square inch. It can operate alone as a controller or with other instruments for limit, alarm or signalling service. Five ranges are available, from 30 lb-300 lb per square inch to 300 lb-3000 lb per square inch. In these devices a mercury switch is operated by a corrosion-resistant bourdon tube, enclosed in a heavy steel case which resists dust, weather and corrosion. Pressure-setting knobs are located on the front and may be of a design immune from unauthorised interference.

Switch action is single-pole, single-throw make or break on pressure rise, depending on the model. The position of the mercury switch is visible through a window in the front of the case. An explosion-proof version is available for use in hazardous atmospheres.

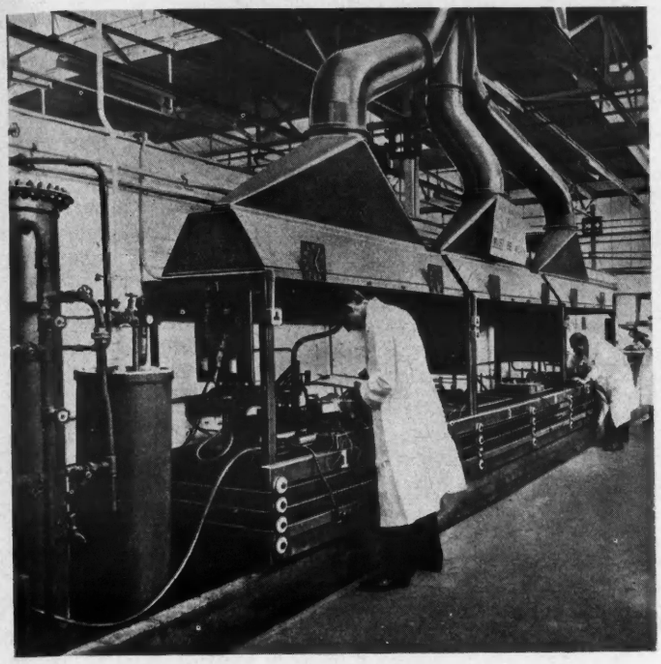
[Reply Card No. E10222]

Catalysed Silicone Rubbers

THERE have been made available by Imperial Chemical Industries, Ltd., the first three of their "Silcoset" rubbers, which are silicone rubbers that do not require curing at high temperatures. The three, "Silcoset" 100, 101 and 102, are respectively a liquid, a pourable paste, and a stiff paste, and they become solid after the addition of a catalyst; two curing agents, A and B, are available to give a choice of curing times of the order of hours or days. For large components or parts intended for service at high temperatures, heating during or after curing is recommended. The use of "Silcoset" primer will bond the rubber to copper, steel, brass, aluminium, glass, or epoxy, melamine and polyester resins with a strength equivalent to that of the rubber.

These materials have the usual inertness and wide working temperature range of silicone rubbers—they are not affected by "Skydol" non-inflammable hydraulic fluid—and are recommended for sealing, patching, caulking and potting applications where extremes of temperature are encountered. One particular use suggested is the construction of moulds for casting plastics and low melting point alloys; their flexibility allows the construction of the mould to be greatly simplified while the silicone rubber has inherent release characteristics and is able to reproduce the "most minute" surface details. By the addition of silicone fluid or other solvents, "Silcoset" rubbers can be rendered slow to cure and fluid enough to permeate cloth.

[Reply Card No. E10223]



Impregnating sintered nickel plaques with active material on a pilot plant at the battery research laboratories

Battery Research Laboratories

Two laboratory buildings having a total floor area of over 41,500 sq. ft were opened recently to form the new central research and development laboratories of the Chloride Electrical Storage Company, Ltd., at Clifton, near Manchester. The whole site occupies nine acres and includes separate buildings for stores, canteen, heating and steam-generating plant, pumping station and other services. Research on these premises is being actively pursued not only on the development of lead-acid batteries but also on other electrical storage systems, particularly those using nickel-cadmium electrodes in an alkaline electrolyte and those employing silver oxide and zinc electrodes with caustic potash electrolyte. Apart from the improvement of standard types, work is also in progress on the development of batteries of unconventional design that will fit into small or odd-shaped spaces and stand up to exacting conditions of temperature and stress, such as are required for guided missiles, or water-activated batteries for air-sea rescue applications and meteorological balloons.

A section of the laboratories is studying problems involved in the development of a practicable fuel cell. Work is in progress with porous electrodes which ionise oxygen and any fuel gases which can be effectively oxidised—at present using hydrogen as fuel, though later the intention is to include other gases and solid fuels, and to experiment in varied conditions of temperature and pressure.

Study of methods for increasing efficiency in batteries of normal commercial form ranges over a wide field, and spectrophotometry, polurography and micro-analysis are in use for detection and examination of the organic materials added to lead negation plates to increase their efficiency. One particular line of work calling for basic investigation of organic materials is the manufacture of a lead-acid battery which can be stored indefinitely and put into action simply by filling with electrolyte. In this the negative electrode must be protected against oxidation by some suitable substance. A study has been made of various organic anti-oxidants with a view to establishing their basic structure and chemical properties on the one hand, and on the other their effectiveness in preventing the oxidation of lead.

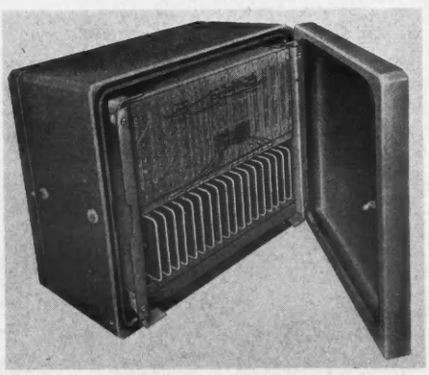
Another development is an alkaline battery in which the grid consists of sintered nickel and the positive and negative active materials are held in the fine pores of the nickel. These plates can be made considerably thinner than the " pocket " type of the conventional alkaline battery. Fundamental study of the polarisation of these porous plates has enabled special designs to be made for use in guided missiles.

Continual search is made for alloys from which lighter and more durable plate grids could be cast, and in this work the laboratories investigate all aspects of grain structure in metal and its effect on the physical and chemical behaviour of alloys. Results of basic research on all these subjects in the chemical laboratories are applied in small pilot plant production of batteries of all kinds (see illustration). For this purpose a full range of equipment is available for all the factory operations of casting grids, pasting plates, and forming and drying under various conditions.

[Reply Card No. E10231]

Process Control Computer

THE newly-formed System Engineering Group of de Havilland Propellers, Ltd., Hatfield Aerodrome, Hatfield, Herts., has developed a low-cost analogue computer, known as " Anatrol " for on-line process control. It is stated that the computing accuracy of this device is compatible with present-day measurement accuracies,



Simplified analogue computer for on-line process control

allowing it to be integrated into existing control schemes, and that its computing potential is equal to a more costly and complex computer system.

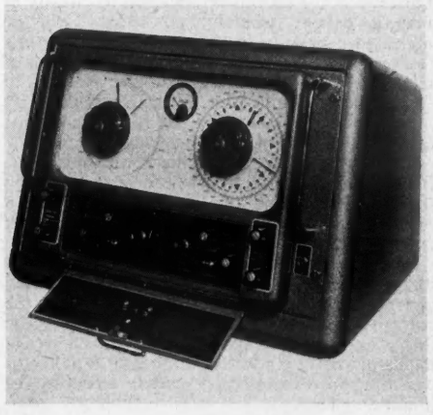
In " Anatrol " the minimum of computing amplifiers and multipliers is formed into an arithmetic unit, which is used to provide a step-by-step solution of the process equations according to a pre-set programme in which each step is selected sequentially by a switch system. Short stores are used to retain information on the result of a step in the solution, these data being used in a later stage of the computation. Long stores clamp the outputs at the last computed figure while fresh values are being determined. A maximum of twenty-five steps is available. Semiconductor techniques are used exclusively, with the exception of some electromechanical switching elements. The machine construction is of module form, and different component-unit combinations may be used according to the problem. Some of the units are seen in the accompanying illustration.

The " Anatrol " computer has a built-in self-checking facility and for errors greater than 1 per cent an alarm is given and the computer can be automatically isolated from the process. Conventional computing equipment could solve equations at speeds which are extremely fast compared with process dynamics, and so it has been found possible in " Anatrol " to adopt a new design approach specifically for process control requirements. This, it is claimed, makes it possible to investigate the benefits of multi-variable control under plant operating conditions at much lower cost than hitherto.

[Reply Card No. E10232]

Automatic D.F. Receiver

FOR ships' direction-finding service in the medium-frequency range (250-550 kc/s), Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex, has introduced the combined receiver and automatic radio goniometer illustrated. The equipment is designed to operate with the Marconi Bellini-Tosi aerial loops. In automatic operation the signal from the fixed loop aerial, resulting from displacement of the goniometer from the null point, is used in conjunction with the signal from the vertical aerial to produce a low-frequency error signal. This activates a servo motor which drives the goniometer to the null point. Sensitivity of the receiver is variable by the use of a two-step gain for automatic working with " normal " and " distant " settings, the former, used in areas of



Medium-frequency direction-finder with automatic or manual goniometer control

reasonable signal strength, reducing the fluctuations of the goniometer pointer due to excessive noise, while in the " distant " position sensitivity is increased by approximately 20 dB. A tuning meter enables the correct setting of the " Normal " / " Distant " control to be selected, and also facilitates accurate tuning. With the service switch in the " Test " position, the tuning meter can also be used to monitor valve feeds and voltages throughout the equipment.

Provision is made for immediate switching from " Auto " to " Manual," enabling bearings to be taken of weak signals in the presence of stronger signals, a situation that might arise when dealing with a distress call. Controls for manual working are behind the hinged cover plate seen lowered in the illustration.

The equipment is suitable for use with the leading makes of gyroscopic repeaters, making it unnecessary to plot ship's head, but a manually-adjusted Pelorus scale enables true bearings to be obtained when a gyro repeater is not fitted.

[Reply Card No. E10233]

SHORTER REPORTS *(Continued)*

Telemetry System

PRELIMINARY information has been issued by the Electronics Division of the Plessey Company, Ltd., Ilford, Essex, on the new "Dictum" telemetry system for indication and control purposes over a two-channel radio link or telephone line. The system is known as "Dictum" (digitally coded transistorised ural-tender metering system) and takes advantage of two new factors : (a) the permission now given by the G.P.O. for point-to-point working by radio link ; and (b) the development of small and reliable data-handling devices as a result of the needs of digital computers.

"Dictum" is arranged to identify outstations by a coded binary number. Subsequent transmission of information from the outstations would be in the form of groups, or scans, each having its own identity, and during each scan provision would be made for the transmission of one analogue quantity and either three or six other digits which could be used to indicate two-state devices. Normally a maximum of thirty outstations would be catered for, each capable of responding with up to eighty two-state indications and fourteen analogue channels. Control arrangements may be provided for a maximum of thirty facilities at each outstation. Arrangements are made for alarms on selector information channels to be transmitted to the control station with a normal maximum delay of about four seconds. In the first instance the outstation transmits an alarm code which alerts the control station and gives an indication on the control desk. Following this indication, examination of the information at the outstation may either proceed automatically or at the initiation of the control engineer. Provision is made for the case of simultaneous alarms arising at two or more outstations. This will be achieved by the use of present delays, whereby outstations will be allocated a priority in the sequence of replying.

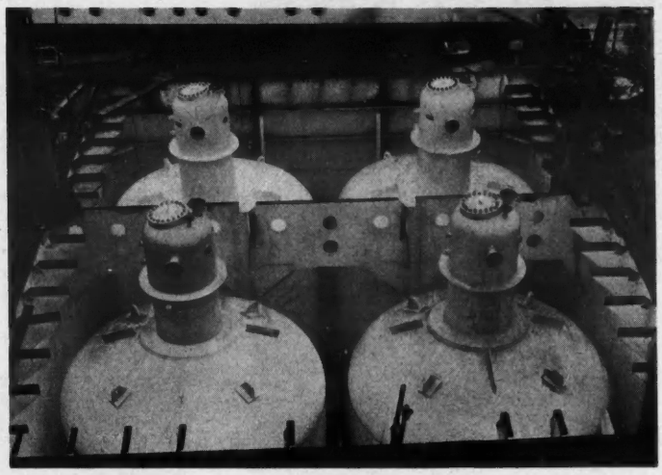
Transmission of information is by a number of telegraph tones, which are normally arranged at frequencies within the speech band. This information can, therefore, be transmitted over any medium capable of conveying speech, such as radio, private telephone line, rented telephone line or carrier. The radio systems functions in the frequency band of 420–480 Mc/s. with a normal channel spacing of 100 kc/s., although it is hoped ultimately to reduce this figure to 50 kc/s.

The basic telemetry system can use either a direct digital input or a d.c. voltage which is then converted electrically into digital form. At the control station the analogue, received in digital form, may be displayed directly by numerical indicators or re-converted to operate a meter or recording instrument calibrated in terms of the original analogue.

[Reply Card No. E10241]

Conversion of Oil Tanker to Carry Liquid Gas

RECENTLY the oil tanker "Gyrotoma," which was built ten years ago for N.V. Curaçaosche Scheepvaart Maatschappij, a member of the Royal Dutch/Shell Group of companies, has been converted to carry liquid propane. This work has been carried out at the North Shields establishment of Smith's Dock Company, Ltd., and has involved the installation of twenty-two high pressure steel containers in the main cargo tanks. These containers, built by Head Wrightson Teesdale, Ltd., will hold a total of 750 tons of liquid propane, while the space surrounding the bottles, together with the original wing tanks, will continue to be available for white oil cargoes. There are ten containers of 37 tons capacity and twelve of 25·5 tons capacity, the former having a diameter of 14ft and the latter a diameter of 12ft. Our illustration shows four bottles in position before closing up the deck. The installation involved a considerable amount of reconstruction work and the cutting of holes in the deck plating to take the neck of the propane bottles which had a diameter of 3·5ft. Before installation the centre tanks were shot-blasted and painted with "Epikote." Existing main oil cargo suction and discharge pipelines were re-sited and for loading and discharging the propane 4in diameter steel lines have been provided together with 4in "Audco" cocks at each bottle, each of which is also fitted with a relief valve set to lift at 250 lb per square inch.



Four of the twenty-two gas bottles in position before closing up the deck of the oil tanker "Gyrotoma". The tanker has been converted to carry a total of 750 tons of liquid propane.

Special machinery has been installed to handle the propane and consists of two six-cylinder diesel engines, mounted in a new deckhouse, each driving hydraulic pumps. These pumps, two of 60 h.p. and one of 10 h.p., generate a pressure of 1500 lb per square inch and four hydraulic motors drive, through gearboxes, two gas compressors and two centrifugal liquid propane discharging pumps. A water sprinkling system and steam smothering lines have been fitted. As built the "Gyrotoma" had a cargo capacity of 7763 tons, the present capacity is 5671 tons of white oil and 747 tons of propane, while the lightweight of the ship has increased from 3200 tons to 4410 hours.

[Reply Card No. E10242]

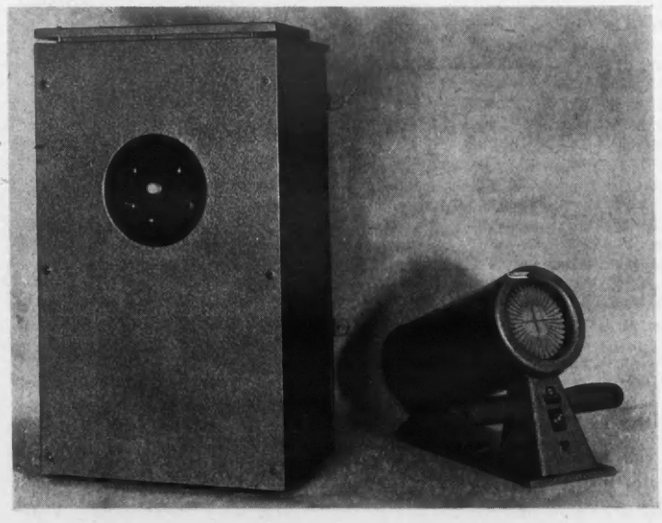
Radar for Small Ships

SMALL size and economy in power requirements have been specially studied in a new radar designed for launches, tugs and other small craft by Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex. We illustrate the transceiver and display units of this equipment, the NR505. The display unit, on the right, is designed for mounting on a deckhead, bench or bulkhead. It incorporates a 5in display which is increased to 8in diameter by an optical magnifier. Power economy is achieved by automatic return to "standby" after two minutes' viewing, but an override switch can be incorporated if continuous viewing is desired. Bearing measurements are taken from a "Perspex" screen in front of the display, and ranges are measured by interpolation between range rings at 0·6, 1·5, 4·8 and 14 nautical miles. Minimum range is 30 yards.

The transceiver unit (on left of illustration) houses all the major electronic equipment, including the stabilised power unit. It is contained in a compact cabinet which can be mounted in any convenient space in the wheelhouse. The five main controls are grouped on a circular plate.

The aerial unit is a 3ft slotted waveguide array, end-fed via a rotating joint. It is driven from a fractional horsepower motor, by means of a toothed reinforced belt, and the whole assembly is mounted on a "Fibreglass" base and covered by a detachable "Fibreglass" radome. The aerial may be fitted directly to the deck or attached to the top plate of a lightweight tripod mast.

(Reply Card No. E10243)



Transceiver and power supply unit (left) and display unit (right) of radar equipment for launches, tugs, &c.

INDUSTRIAL NEWS

Financing Capital Investment

The annual general meeting of Finance Corporation for Industry, Ltd., was held on Thursday, June 2, in London. Addressing the meeting Lord Weeks, the chairman, pointed out that by virtue of the exceptionally large amounts involved for a comparatively short period of time, finance in respect of developments within the steel industry still constituted by far the largest part of the Corporation's business, but that the Corporation was, nevertheless, active in other fields also. Referring to his statement which had been circulated with the report and accounts for the year ended March 31, 1960, the chairman said that negotiations in connection with further schemes of development were proceeding a tpresent although, as it so happened, no new agreements were entered into during the year under review. On the contrary, some of the Corporation's clients found that the more favourable conditions prevailing during the latter part of 1959 and continuing into this year enabled them to effect repayment of some part of their loans earlier than was originally contemplated.

Reviewing the results of the Corporation's fifteen years of existence, Lord Weeks said that he believed the Corporation had come to be accepted as a valuable part of the post-war financial mechanism, although the cases qualifying for its help had been and would continue to be necessarily limited in number but large in amount. It was his considered opinion, the chairman added, that the necessity for British industry to maintain its competitive position by accelerated re-equipment and expansion could not fail to require the Corporation to continue to play an important part in financing capital investment.

Industrial Trends

The report on the eighth inquiry made by the Federation of British Industries into industrial trends in this country indicates a continued rise, over the past four months, both in orders received and in output. The report is based on information provided by 714 representative British companies ; it says that there is " a sustained optimism about the future though it is less strong than it was in February." The immediate limitations to further increases in output are more through inability to increase production than through lack of orders. But the report emphasises that the prime factor limiting production is shortage of labour, particularly skilled labour. At the same time, one-sixth of the firms questioned said that they would be limited by their own capacity and about the same proportion through a shortage of bought-in materials and components. Confirmation of this is given by the marked rise in the number of those who are finding it more difficult to obtain the labour they require and by the small rise in the number of those who are working their plants to capacity.

The report goes on to say that for the first time for a year there has been, on balance, no change reported in the number of hours worked. This situation emphasises how greatly the future increases in output must depend upon further capital investment designed to save labour. The replies from firms suggest that higher investment programmes will be authorised in the next twelve months, little change in expenditure or building being indicated but an appreciable rise in expenditure on plant and machinery. At present, the orders for capital equipment which firms are receiving are showing a continued upward trend. The effect of recent wage increases is shown by the fact that the rise in costs per unit is the strongest reported since these trend inquiries were started over two years ago. Selling prices are reported on balance to have risen for the first time in these inquiries, though not to the same degree as costs. Consequently, the F.B.I. comments, there is " a slimming of profit margins per unit."

The broad conclusion from the inquiry is that further expansion in the economy can be expected over the next few months, though at a lesser rate than over the past year. Beyond that much depends upon two factors, namely, on the ability of management and labour to increase output per man-hour and on whether the recent rise in the import of raw materials for the build-up of stocks, and of some consumer goods, will come to an end or be matched by a parallel rise in exports.

Iron and Steel

Iron and steel production in Great Britain during May dropped a little from the figures reached in April. Pig iron output averaged 299,100 tons a week and steel output, 475,400 tons a week. That means, of course, that production was at annual rates respectively of 15,554,000 tons and 24,723,000 tons. The comparable annual rates in May last year were 12,504,000 tons (pig iron) and 19,999,000 tons (steel). The Iron and Steel Board says that the reduction in output in May was caused partly by relining of blast-furnaces and repairs at steelmaking plants.

During the first quarter of this year, the home usage of finished steel is estimated to have been 3,660,000 tons on a seasonably corrected basis, or over 20 per cent greater than in the first quarter of 1959. This result represents a gain of 5 per cent over the previous highest figure which was reached in the second half of 1957. The Board states that the rise in steel usage since the latter part of last year is rather more than would be expected from the rise in output of the various steel consuming industries. But a similar divergence has appeared in the past, in 1955 for instance, at times of rapidly increasing industrial activity. Among possible reasons for the difference in the expansion of the amount of work in progress in the engineering industries.

Hours and Earnings

The Ministry of Labour's next half yearly inquiry, in October, into the earnings and hours of some 7,000,000 manual workers is to be expanded to show not only the average of their earnings in the week to which the inquiry relates, but the spread of earnings above and below that average. Employers will be asked to give separate numbers of full-time adult employees in each of thirty-one specified ranges of earnings. The British Employers' Confederation recalls in its *Bulletin* that, two years ago, the Ministry of Labour told the Confederation that it proposed to make an inquiry into the individual hours and earnings of all adult workers in the industries covered by its usual half-yearly inquiries. The Employment and Manpower Committee of the British Employers' Confederation examined the Ministry's proposals and pointed out that such an inquiry, in the detail suggested, would be of doubtful value and would involve a very large amount of work for employers. The Ministry accepted the views of the Confederation and subsequently proposed the more limited inquiry to be made in October next which will greatly reduce the volume of work that would have otherwise fallen on employers.

In a statement issued recently the Ministry of Labour said that, in view of the wide variations in the earnings of different grades of workers in many industries, statistics of average earnings might be misleading unless supplemented by information about such variations. The only information on this topic which was available was that provided by a similar inquiry in 1938, but it was realised that this was now out of date because of the considerable change there had been in conditions in industry and in the economy.

Oil Consumption

According to information received from the Petroleum Information Bureau oil consumption in the United Kingdom, during the first three months totalled 11,218,835 tons, an increase of 21·7 per cent over the corresponding quarter in 1959. Rapidly rising fuel oil deliveries were largely responsible for the increase and amounted to 4,976,880 tons, while the total for gas/diesel oil deliveries rose to 1,010,625 tons. Although the winter was comparatively mild burning oil consumption recorded an increase of 560,090 tons, and there was a substantial rise in deliveries of motor spirit, a total of 1,646,180 tons being attained, while consumption of derv fuel advanced to 619,333 tons.

Constructional Work

Contractors in Great Britain carried out constructional work to the value of £500 million during the first quarter of this year, according to provisional figures collected by the Ministry of Works. This was £36,000,000 more than in the same period last year, which, however, included the Easter holiday. There was little change compared with the fourth quarter of last year. The amount of work done on housing for public authorities fell, but the upward trend in housing for private developers continued. There was virtually no change in the amount of work done (other than housing) for public authorities and work on industrial building remained steady. Miscellaneous building fell for the first time for a year. In April, employment, allowing for seasonal adjustments, was at about the same level as it reached at the end of last year.

PERSONAL AND BUSINESS

Appointments

MR. LIONEL HARPER has been appointed managing director of Dowty Hydraulic Units, Ltd.

MR. A. G. SHOVE, A.F.R.Ae.S., has been appointed sales manager of British Aerojet, Ltd.

MR. JAMES BOYD WEBSTER, M.I.Mech.E., works manager of Crane, Ltd., has been appointed to the board of directors of the company.

MACHINERY (CONTINENTAL), Ltd., states that Mr. S. A. Mansfield has been appointed technical sales manager responsible for C.P.O.A.C. pneumatic concrete placers, R.G.A. tampers and R.G. screeders.

BRITISH INSTITUTE OF MANAGEMENT announces that fellowship of the Institute has been offered to and accepted by Sir Edward Thompson, Mr. R. S. Drake, Mr. L. Harper, Mr. G. Ireland, Mr. H. C. Ryan and Mr. W. C. Turriff.

THE ALUMINIUM DEVELOPMENT ASSOCIATION announces that General Sir Geoffrey Bourne has been appointed director-general in succession to Air Commodore W. Helmore who has retired after fourteen years as director-general of the Association.

MR. A. S. BRACK has been appointed plastics representative for Northern England for Turner Brothers Asbestos Company, Ltd. He will specialise in "Duraglas" glass-fibre reinforcements and "Durestos" resinated asbestos moulding materials.

THE FAIREY COMPANY, Ltd., has announced the appointment of Mr. D. W. Lee-Smith as secretary of the company, in succession to Mr. L. S. Dawkins. Mr. Lee-Smith is at present chief accountant and he retains this position.

THE MINISTRY OF AVIATION announces that Captain J. A. LEVERS has been appointed deputy controller of aircraft (military) in succession to Rear-Admiral A. S. Bolt. Captain Levers is being promoted to Rear-Admiral and will take up his new duties in July.

INTERNATIONAL HARVESTER COMPANY OF GREAT BRITAIN, Ltd., announces that Mr. J. D. Parkinson, parts manager, has been appointed assistant manager of domestic sales. He has been succeeded as parts manager by Mr. J. P. O'Shea. Mr. R. G. Baird has been appointed assistant parts manager.

TELECOMMUNICATION ENGINEERING AND MANUFACTURING ASSOCIATION has announced that Mr. R. A. Moir, director of Standard Telephones and Cables, Ltd., has been elected chairman of the Association and Mr. W. F. Oakley, director of Automatic Telephone and Electric Company, Ltd., has been elected vice-chairman.

ARMSTRONG WHITWORTH (METAL INDUSTRIES), Ltd., states that Mr. William McK. Wright has been appointed resident area sales manager, Middle East. His address is Imm Almani, Rue Bliss, Ras Beirut, Beirut, Lebanon. Mr. Guy Chesham, Wien 1, An Der Hulben 1-12A, Austria, has been appointed special representative to the Soviet Bloc of countries.

CATMUR MACHINE TOOL CORPORATION, Ltd., announces that Mr. N. W. S. Catmur, having reached retirement age, will relinquish his position as managing director of the company on July 31. He will remain with the company as deputy to the chairman Sir Wm. Palmer. His son, Mr. Peter S. Catmur, will assume the position of managing director.

MR. L. B. HISLOP, M.R.I.N.A., a deputy chief ship surveyor of the Ministry of Transport, has been appointed principal sea transport surveyor, with effect from July 1, in succession to Mr. W. J. G. Hawkins, M.R.I.N.A., who is retiring from the department. Mr. Hislop will be succeeded by Mr. H. W. Terry, M.R.I.N.A., a senior ship surveyor at headquarters.

THE CENTRAL ELECTRICITY GENERATING BOARD, SOUTHERN PROJECT GROUP, announces the following appointments: Mr. L. W. G. Mason, A.M.I.Mech.E., has been appointed resident site engineer for the Board's fifth nuclear power station to be built at Dungeness in Kent; Mr. M. V. Horsfield, A.M.I.E.E., has been appointed resident site engineer for Belvedere power station; Mr. A. Hanlon, A.M.I.E.E., A.M.I.Mech.E., has been appointed resident site engineer for Northfleet power station; Mr. S. F. Mogridge, A.M.I.Mech.E., has been appointed resident site engineer at Bankside "B" power station.

MR. HARRY VINCENT, F.I.O.B., managing director of Bovis Holdings, Ltd., has been elected chairman and managing director. He remains chairman of Leslie and Co., Ltd., a member company of the Bovis Holdings Group. Mr. D. E. Woodbine Parish, F.I.O.B., a director of Bovis Holdings, Ltd., has been appointed an additional managing director of that company. He remains chairman of Bovis, Ltd., also a member company of the Bovis Holdings Group.

Business Announcements

BARFORDS OF BELTON, Ltd., is the new title under which Barford (Agricultural), Ltd., Grantham, will operate in future.

AMPEX ELECTRONICS, Ltd., Reading, Berks, has announced the establishment of a basic research unit. Mr. Eric D. Daniel is to head the new research facility.

GRIFFIN AND GEORGE, Ltd., Ealing Road, Alperton, Wembley, Middlesex, has purchased the whole share capital of R. and J. Beck, Ltd., Watford and Kentish Town.

MAGNUS CHEMICAL COMPANY, Ltd., has opened a new Midland office at 751, Bristol Road South, Northfields, Birmingham, 31 (telephone, Priory 4979).

MR. OMER G. VOSS, managing director of International Harvester Company of Great Britain, Ltd., has returned to the United States for re-assignment to an important position in the parent company.

ALFRED BULLOWS AND SONS, Ltd., Long Street, Walsall, Staffs, has established a subsidiary company in Australia known as Alfred Bullows and Sons (Aust.), Pty. Ltd., Ethel Avenue, Brookvale, Sydney, N.S.W.

RHODES, BRYDON AND YOUATT, Ltd., Reddish Engineering Works, Stockport, Cheshire, states that its head office has moved from Waterloo Engineering Works to the more extensive premises of its new works at Reddish (telephone, Heaton Moor 6211).

HAMWORTHY ENGINEERING, Ltd., Poole, Dorset, has purchased Schieldrop and Co. of Stotfold, Bed., manufacturer of industrial oil burning equipment for kilns and furnaces. Schieldrop and Co. will continue to trade as a separate entity and Mr. I. P. Frost will continue as managing director.

BAKER PERKINS, Ltd., Peterborough, has acquired the Granbull Tool Company, Ltd., Kingston on Thames, Surrey, and Twickenham, Middlesex. Mr. F. G. Bull will remain managing director and Mr. R. H. Wilkins will become chairman of the company, which will continue to operate as a separate entity within the group.

VICKERS, Ltd., Vickers House, Broadway, Westminster, London, S.W.1, and HERR HANS J. ZIMMER of Frankfurt-on-Main announce the formation of the joint enterprise Hans J. Zimmer Aktiengesellschaft Fuer Industrieanlagenbau (Hans J. Zimmer, Ltd., for industrial plant construction) in which each party holds an equal share of the equity. The company will be active in the field of plant design, engineering and construction for the chemical and man-made fibre industries. Vickers, Ltd., and Herr Hans J. Zimmer will also hold equal shares in High Polymer and Petrochemical Engineering, Ltd., of London.

L.C.E., Ltd., the recently formed electronics firm jointly-owned by Joseph Lucas (Industries), Ltd. (through its subsidiary G. and E. Bradley, Ltd.,), and the Collins Radio Company of America, has announced further details. The nominal capital of the new company is £100,000, in 50,000 "A" and 50,000 "B" shares of £1 each. Chairman of the board is Lord Halsbury of Joseph Lucas (Industries), Ltd., and Mr. Jonathan H. Lasley of Collins Radio Company of England is vice-chairman. Other directors include Mr. C. F. Finch of G. and E. Bradley, Ltd., Mr. James G. Flynn, Jr., Mr. F. C. Huston and Mr. R. C. Frost of Collins Radio Company, and Mr. C. W. Griffiths of Joseph Lucas (Industries), Ltd. Mr. Kenneth Jones has been appointed a director and general manager of L. C. E., Ltd.

Contracts

THE CEMENTATION GROUP OF COMPANIES announces that Thorne Colliery in Yorkshire, closed in 1957 when its two main shafts were flooded, is likely to be reopened in 1963. A contract valued at £757,420 has been awarded to the Cementation Company, Ltd., by the National Coal Board for the relining and "making-safe" of the shafts.

JOHN HOWARD AND CO., Ltd., has been awarded a contract by the Admiralty, valued at approximately £145,000, for the demolition and removal of two existing oil storage tanks, pipe work and pump house, and the removal of a section of an existing bund at Rosneath, Dumbartonshire. When the demolition works have been completed, work will start on the construction of a petrol, oil and lubricating depot on the same site. The contract is due to be completed by June, 1962.

THE ENGLISH ELECTRIC COMPANY, Ltd., has received an order from the C.E.G.B. for a 400MVA transformer, to be installed at the High Marnham end of a 64 mile long high-voltage transmission line from High Marnham Power Station, Notts, to Monk Fryston, near Leeds. It will connect the 275kV super-grid to this line, which will be uprated to 380kV. It will be a 400MVA, 275kV/380kV, three-phase, 50 cycles auto-transformer, with OF cooling. The transformer will be manufactured and tested at English Electric's Stafford works; the tests will include a full-load loss heat run.

HOLLAND & HANNEN AND CUBITTS Ltd., and its Canadian associate ANGLIN-NORCROSS CORPORATION, Ltd., have been awarded a £1,500,000 contract to build the 261 room Trinidad Hilton Hotel. Work on the site has started and it is expected to complete the hotel on October 1, 1961. It will then be leased from the Trinidad Industrial Development Corporation by Hilton Hotels International Inc. The hotel is being constructed on the crest of a hill outside Port-of-Spain, the seven-storey building following the contours of the hillside. Approach to the hotel will be from a road linking up with the main route to Piarco Airport, 14 miles away.

HOLLAND & HANNEN AND CUBITTS (NORTH WEST), Ltd., is building a new compound mill at Bromborough, Cheshire. The cost of the building and civil engineering work is approximately £1,000,000 and the mill is for the British Extracting Company, Ltd., of Bromborough Port, New Ferry, Birkenhead, Cheshire, who are oil seed crushers and manufacturers of cattle, sheep, pig and poultry foods for Lever's Feeds, Ltd. Work is programmed to be completed by September, 1961. The mill will comprise a raw materials warehouse, silo building, production building and finished products warehouse, with administrative buildings and ancillary work. The consulting engineers are Messrs. Frederick S. Snow and Partners.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd. (HEAVY PLANT DIVISION), has received an order from Samuel Fox and Co., Ltd., to supply a 5000 h.p., d.c. motor and auxiliary drives for a new 40in reversing billet mill at the company's Stocksbridge works. The mill motor will be supplied from a mercury-arc converter installation which has already successfully undergone extensive trials in a similar mill at the same works. The converter consists of ten grid-controlled pumpless steel tank units connected to give a twelve-phase output of 4000kW. A fast pneumatic switch in the armature circuit caters for the reversal of motor torque and allows regenerated power to be accepted back into the a.c. supply system, through the converter. Static amplifiers, sequence control system, and supervisory and alarm equipment will be mounted in cubicles adjacent to the rectifier units on a gallery overlooking the motor room. A closed-loop system of speed control will incorporate overriding limitation of current, voltage, and acceleration.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., has received a contract from the Civil Aviation Administration (Air Department) of New Zealand, for the supply and installation of two 50kW, 50cm surveillance radars, type S264, together with three display consoles and other ancillary equipment, at Momona Airport, Dunedin. The value of the contract is in the region of £80,000. It was obtained through Amalgamated Wireless (Australasia), Ltd. The type S264 radar is capable of handling aircraft approaches from distances well in excess of 100 miles and feeding information to an instrument landing system or precision approach radar. Similarly it can regulate departure separations out to these distances. It is a characteristic of the 50cm wavelength that aircraft echoes are not obscured by precipitation, but the centres of heavy rainstorms are faintly visible on the display screens, enabling aircraft to be plotted through these storm centres or guided round them. Moving target indicators are employed for the suppression of permanent echoes. Outgoing aircraft can be plotted from take-off, and incoming aircraft to touch-down. The S264 was the first 50cm equipment of its power in the world and was first installed at Wellington, New Zealand, in 1959.

CONTINENTAL AFFAIRS

by Our Continental Editor

Fifty-Cycle A.C. Locomotives in Russia

A group of French manufacturers is building fifty locomotives for lines of the U.S.S.R. Railways now being electrified in the 50 c/s system, and a further twenty-five for the Chinese Republic Railways. All are rectifier locomotives. Ten of those for Russia and the twenty-five for China are equipped for regenerative braking by operating the rectifiers as inverters with automatic control of braking effort.

EXPERIMENTS with a.c. traction at 50 c/s were first made on the railways of the U.S.S.R. in 1938, when a locomotive with multi-anode rectifiers was built at the Dynamo works. Further progress was delayed by the war, but in recent years the development of this form of traction in Western Europe has been watched with interest, and since 1956 the railways have conducted trials on the 90 mile section of line between Ojerelie, near Moscow, and Pavletz, which has been electrified at 25kV, 50 c/s. The results achieved here led to the decision to undertake large-scale electrification on the 50 c/s system, beginning with the 499 miles of the Eastern Trans-Siberian Line between Marinsk and Taichet.

Two locomotive designs for the 50 c/s system have been developed in Russia since the war Both have the C_0-C_0 wheel arrangement and are equipped with water-cooled ignition rectifiers feeding 1500V d.c. motors similar to those in locomotives operating on the 3000V d.c. sections of the railways. Alternatives to rectifier drives have not been pursued beyond the test bed stage so far, for by the time work on 50 c/s electrification was resumed in the U.S.S.R., ample evidence was available from experience in France of the practical advantages of rectifier systems.

After the prototypes of the first two locomotive classes had appeared in 1954, ten more locomotives were built, incorporating minor modifications. They form the "N-0" class and have a one-hour rating of 3600 h.p. A further series of locomotives, class "N-60" was based on experience with the "N-0" class and differs from them in having independent instead of articulated bogies and a one-hour rating of 5430 h.p. In this class the influence of French practice in mechanical design begins to be seen. The bogies have a swing-pivot system with conical rubber seatings and radius arm axlebox mountings similar to those in the French National Railways "7100" class, 1500V, d.c. locomotives built by Alsthom for the Paris–Lyons electrification. Control is by cam-operated air-break contactors at medium voltage in conjunction with a buck-and-boost transformer, giving thirty-three running notches. An electric servo-motor notches the equipment up automatically under the control of a time relay.

The scope and pace of the a.c. electrification programme made it necessary to acquire locomotives from builders outside Russia, and orders were placed in 1957 with a French group for fifty C_0-C_0 locomotives broadly similar to those already constructed but of higher rating. These have been built by a group of firms formed by Alsthom and Le Matériel de Traction Electrique, the latter comprising Société des Forges et Ateliers du Creusot (Usines Schneider), Forges et Ateliers de Constructions Electriques de Jeumont, and Le Matériel Electrique Schneider-Westinghouse.

The French-built locomotives are divided into three sub-classes, all with a one-hour rating of 6300 h.p. and a continuous rating of 6000 h.p. Ten locomotives (Nos. N.01–N.10) are for express passenger traffic and have fully spring-borne motors (Fig. 1); thirty (Nos. T.01 to T.30) are for goods traffic with axle-hung motors; and ten (Nos. TP.01 to TP.10) are also goods locomotives and identical with the T.01–T.30 series except for being equipped with the Schneider-Westinghouse ignitron regenerative braking system. This is the first application of the system to locomotives of comparable power for heavy and relatively fast traffic.

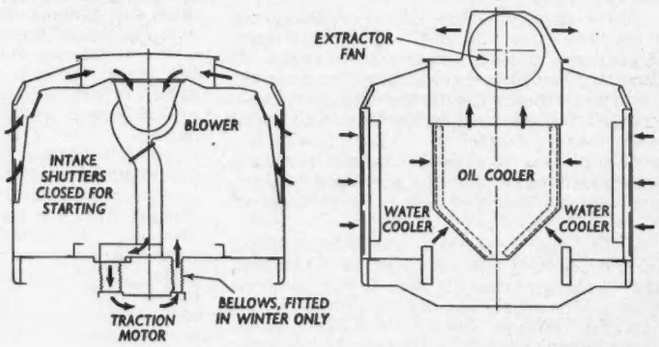


Fig. 2—Air flow to traction motors in winter (left) and in central compartment (right)

Some particulars of the three series of locomotives are given in the accompanying table:

	T.01 to T.30 and TP.01 to TP.10 (Goods locomotives)	N.01 to N.10 (Passenger locomotives)
Length	75ft 8in	75ft 8in
Width	9ft 9in	9ft 9in
Wheel diameter	4ft 1in	4ft
Bogie wheelbase	15ft 4in	15ft 11in
Speed at one hour rating	28·5 m.p.h.	46 m.p.h.
Speed at continuous rating	29 m.p.h.	46·6 m.p.h.
Maximum speed	62 m.p.h.	99·4 m.p.h.
Tractive effort (one hour)	79,400 lb	44,200 lb
Tractive effort (continuous)	76,000 lb	44,100 lb
Maximum tractive effort	114,700 lb	72,700 lb
Total weight	135·7 tons	124 tons

Fig. 1—One of the fifty locomotives built in France for 50 c/s electrified lines of the U.S.S.R. railways. The locomotive illustrated is of class "N.01" for passenger service

Apart from their 5ft gauge and high normal starting effort of 114,000 lb, requiring a centre-coupler with a strength of 300 tons instead of the usual 75 to 80 tons, the locomotives differ from general European practice in the structural measures necessary for operating in temperatures between +104 deg. and −58 deg. Fah. For this reason the body is divided into a pressurised, air-conditioned compartment at each end and a central non-conditioned compartment housing the transformer, tap-changer and stabilising resistors (when fitted). Air enters the latter compartment through the ignitron water and transformer oil coolers and is exhausted through the roof clerestory by two extractor fans, one of which is seen in Fig. 2. In the locomotives with regenerative braking this air flow also cools the stabilising resistors.

The plan view of the locomotive (Fig. 3), shows the two methods of ventilation in the end

CONTINENTAL AFFAIRS *(Continued)*

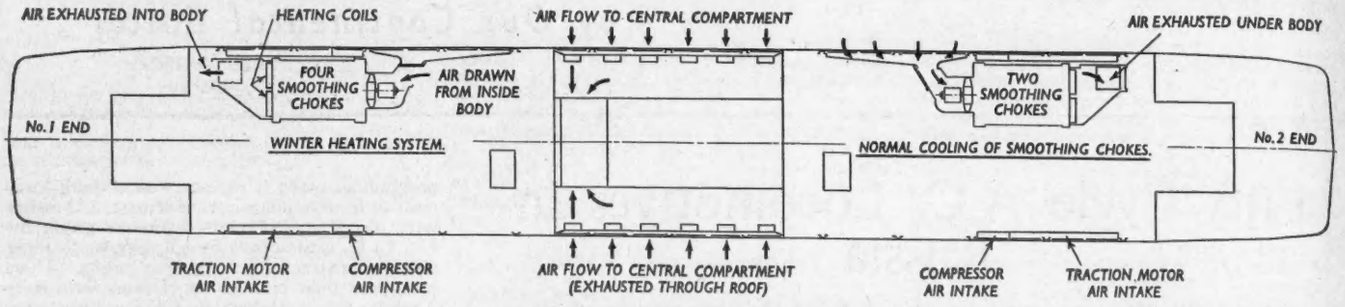


Fig. 3—Layout of cooling systems in locomotive

compartments. In normal conditions the small blowers for cooling the smoothing chokes, arranged in one block of four and one block of two (see also Fig. 4), take air from outside the locomotive and discharge it under the body after it has passed over the chokes. Conditioning is then provided only by the compressor cooling air. In winter the smoothing choke blowers take air from inside the body and discharge it into the body again after it has passed over heating coils, and the external intakes to the compressors are closed.

Fig. 4 also shows the "Arno" single-phase/three-phase converter which supplies the twelve three-phase auxiliary motors and drives the generator for battery charging. The set is run up to speed by a single-phase motor on the same shaft which is energised during the starting period only.

Two blowers mounted under the roof, one above each bogie, provide the traction motor ventilation. This operates in three ways, as follows :

(*a*) Summer ventilation. Air enters through inlets in the body sides, is ducted to the blowers, and discharged through the motors to atmosphere. The air for cooling the compressors, is exhausted through louvres, and the traction motor blowers draw their air direct from outside the locomotive.

(*b*) Winter heating. Extra bellows connections are fitted in winter to return the air to the body after passing through the motors. On starting in winter, air is drawn from and returned to the body.

(*c*) Winter ventilation. When the motors have reached a satisfactory operating temperature, the closed circuit ventilation continues, but an automatically controlled amount of air is admitted from outside.

The bogies of all locomotives are almost identical with those of the French National Railways "7100" class mentioned earlier, apart from the provision of roller bearing axleboxes throughout and the nose suspension of the goods locomotive motors. The body is unusually long (69ft) and is a welded, stressed-wall tubular structure designed for a centre coupler without side buffers. There are no windows, the side walls accommodating only the large number of filters required for excluding dust and snow from the special ventilation system.

In most respects the power circuit is similar to that of the French National Railways "16000" class Bo-Bo rectifier locomotives, having a tapped auto-transformer for voltage control giving thirty-two running notches from 80V to 1060V with 25kV input, but the air-operated tap-changer is of circular form and is of Compagnie Electro-Mécanique construction, derived from the Brown-Boveri resistance-transition tap-changers in the French prototype dual-frequency locomotives. This is illustrated in Fig. 5. The segments connected to the transformer tappings are mounted in two concentric circles on an insulating backplate, which separates the tap-changer from the transformer, each having its own oil. The segments are traversed by rollers carried on a rotating arm driven by an air servo-motor, and they ride, also, over two concentric tracks connected to the cam-operated tap change contactors. Operation of the contactors is synchronised with the rotation of the selector so that the transitions from tap to tap inside the tap-changer are made off load, all current-breaking duty being performed by the contactor contacts.

The rectifier consists of 10in Schneider-Westinghouse ignitrons housed in cubicles each containing two rectifiers and their excitation circuits. Six pairs of rectifiers provide full-wave rectification for the traction motors, with return to the centre tap of the transformer secondary. A seventh pair of similar units is provided in the locomotives with regeneration for separate excitation of the traction motor fields while braking. The rectifiers have a continuous rating of 750kW and a short term rating of 950kW at 800V.

The traction motors, all connected in parallel, are six-pole machines, class "H"-insulated, with a rating of 1000 h.p. at 1080A, 750V, and weighing 3¼ tons. Field-weakening to the extent of approximately 52 per cent is provided by inductive shunts. Each motor is connected in series with a 3·9mH smoothing choke weighing 946 lb. The machines were built by Alsthom and Jeumont. Those in the passenger locomotives are fully springborne and drive through

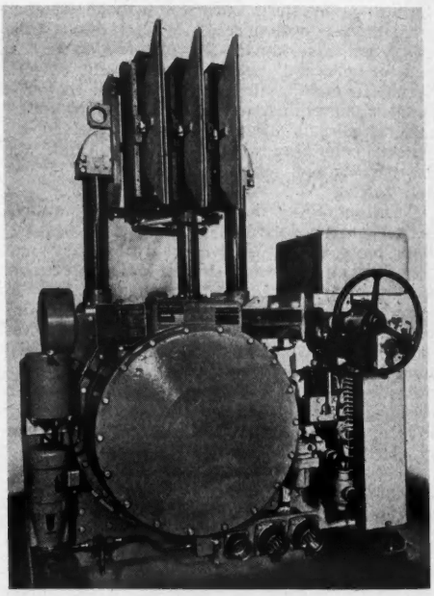


Fig. 5—Rotary tap-changer. The selector mechanism is inside the drum-shaped enclosure and current is broken by the three external contactors

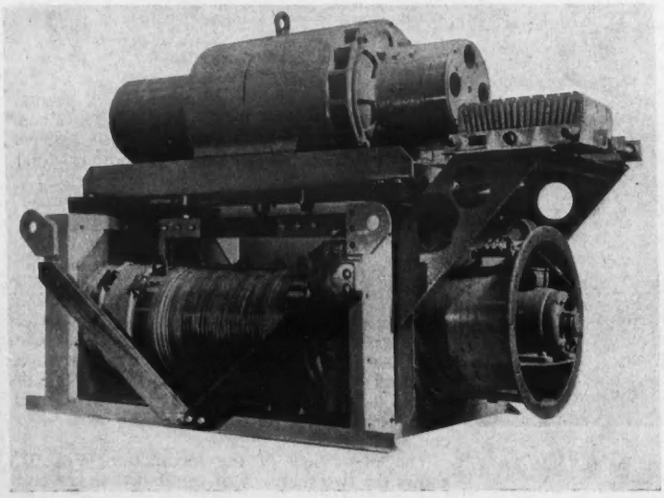


Fig. 4—Smoothing choke and blower assembly, with "Arno" single-phase/three-phase converter for auxiliary supplies mounted above

Alsthom floating-ring flexible transmissions. In the goods locomotives the drive is through resilient gearwheels with coil springs between centre and rim.

Regenerative Braking

For regeneration in the locomotives the main traction rectifiers are operated as inverters. A phase shift is introduced by control of the ignitron firing point, using the output of a small a.c. generator to give a fixed shift and deriving an automatically variable shift from electronic apparatus. Two methods of braking are thus available. With the automatic scheme the driver selects one of nine pre-set speeds on his controller. This adjusts the phase-shift so that at any of the pre-set speeds a constant voltage is returned to line. If the speed of the train at the moment of beginning regeneration is above or below the selected speed, the automatic electronic regulator adjusts the phase angle until the correct conditions are obtained and then holds the train speed and regenerated voltage constant in any change of gradient and load. If, for example, the driver

selects 25 m.p.h. while the train is travelling at a higher speed, the regenerated voltage will exceed a fixed reference voltage corresponding to this braking notch and the effect is to reduce the inverter phase shift, thereby increasing the load on the motors acting as generators, until the speed drops to 25 m.p.h. A limit is set automatically to the regenerated current at 4200A, and if the corresponding braking effort is insufficient to reduce the train speed to the selected speed, supplementary use must be made of the air brake.

The lowest speed at which automatic control of regeneration is available is 18½ m.p.h. Below this speed the train may be braked regeneratively almost to a standstill by manual control of the excitation from the braking ignitrons, the traction rectifiers then acting as inverters with a fixed phase-shift. The methods of regeneration described are to be incorporated in twenty-five similar C_0-C_0 locomotives (but for 4ft 8½in gauge) which have been ordered from the same group of builders by the Chinese Republic Railways.

1·5 Cubic Metre Dumper

We have received details of the "Motrac AS 150" dumper made by Orenstein-Koppel und Lübecker Maschinenbau Aktiengesellschaft, Dortmund. The equipment which has previously been available in a 1 cubic metre version is shown in the accompanying illustration. It has a fully loaded service weight of 4320 kg of which 2500 kg is useful load (reduced to 1080 kg on made-up roads). The vehicle measures overall 3130mm by 1840mm by 1650mm height, has an 1830mm wheel-base, 1500m wheel separation, and a 1550mm turning radius (to inner wheel). Powered by an O & K diesel developing 16 h.p. at 1650 r.p.m., it is driven by way of a single disc dry clutch and gearbox with five forward speeds (3·4 to 16km per hour) and one reverse (5·1km per hour). Electrical equipment includes starter, dynamo, oil pressure switch and temperature indicator, as well as (optionally) permanently dipped, grille-protected headlamps, flashing direction indicators and stop lights. The dumper holds 1·5 cubic metres heaped and 1·2 cubic metres struck level.

1·5 cubic metre dumper truck equipped with 16 h.p. diesel and gearbox with five forward speeds and one reverse

Pirttikoski Power Station

WITH the commissioning a few weeks ago of the second set, the construction of Pirttikoski Power Station has been completed. The station is situated on the Kemi River, about 25 km south of the polar circle, and possesses the largest water turbines installed in Finland to date. There are two vertical Kaplan turbines of 74,600 h.p. to 83,400 h.p. each, at a head of 22·11m to 29m, and a flow rate of 286 to 232 cumecs. With a head of 29m and increased flow, up to 91,300 h.p. can be developed. The turbine thrust bearing has to support a load of 1300 tonnes, made up of an axial water load of 780 tonnes, and the weight of the rotating parts of turbine and generator.

The generators are machines of 70MVA nominal output, at cos ϕ=0·95, and 13·8kV, 115 r.p.m. Runaway speed is 290 r.p.m. The stator is divided into four sections, and has an internal diameter of 8·4m. The rotor weighs 290 tonnes and has linked pole laminations. Its moment of inertia amounts to 15,870 tonnes per square metre. With full river regulation, there will be a mean annual output of 530 million kWh which for the most part will be transmitted at 400kV to Southern Finland, over a distance of nearly 700 km. There is also a 220kV connection with the Swedish grid.

The Pirttikoski scheme utilises the power of the falls of the same name which are situated at Pisiö where the Kemi changes from a southerly to a north-westerly direction. Between the impounding level at 125m sea level and the tail-race at 99m sea level there is a gross head of 26m (net, 25·5m).

The dam is an earth structure with concrete apron piling reaching from the impermeable core down to bedrock through approximately 20m thick moraine. Flanking the dam are two weirs, one on either side and each consisting of two Taintor gates and scour culverts.

The power station is situated underground in the local granite rock. Two intake passages 60m long and 130 square metres in area lead to the turbines. They are lined with 40cm thick concrete anchored in the rock.

Up to the generator floor level, the machine hall walls are concrete-lined. The rock face of the roof is secured with wire mesh sprayed with concrete. Underneath a second timber roof, and outer walls separate from the rock, provide protection from water seeping down. Precision blasting was resorted to for excavating the turbine spirals which were subsequently coated with a thin layer of reinforced concrete.

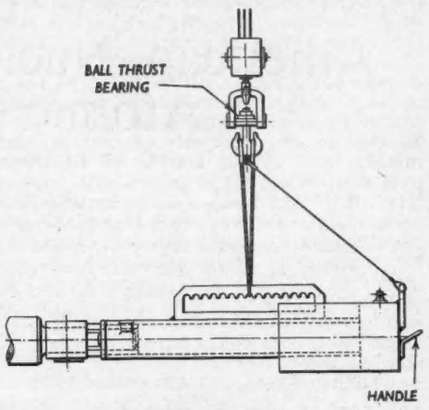
The draught tubes are approximately 25in high and continue horizontally for about twice this distance. Only the upper part is clad with steel, the rest is concrete-lined. Maximum difference between the impounding level and the bottom of the draught tube is 65m.

After joining up within a horizontal distance of 80m from the turbines the tail-races continue into the 29m-high surge chamber (80m to 109m sea level) which is 16m wide at the bottom and broadens to 17·5m at the top. Its free surface amounts to 8000 square metres. Downstream of this is the concrete-lined tail-race tunnel, which has a width of 16m, and a cross-sectional area of approximately 350 square metres. This tunnel is about 2·5 km long and continues into a 450m-long open tail-race blasted into the rock. A 5·5km-long logging flume with a capacity of 10,000 logs per hour by-passes the power station.

Pirttikoski is part of the long-term development of the Kemi and its tributaries, for which the Kemijoki Oy owns the concession. Besides Pirttikoski, three other stations (Isohaara, Petäjäskoski, and Jumisko) have been completed, and Valajaskoski is under construction. Altogether, some forty power stations are envisaged. The catchment area above Pirttikoski is just under 27,800 square kilometres, of which 2·5 per cent are lakes. The mean flow rate is 283 cumecs (maximum flood rate 2150 cumecs, minimum flow 65 cumecs). Contractor for the turbines was Escher-Wyss A.G., Zurich, and for the generators, Siemens-Schuckertwerke Aktiengesellschaft, Berlin-Erlangen.

Roll Changing Device

For facilitating the changing of rolls in the medium strip mill of Hoesch A.G., at Hohenlimburg, a device has been perfected which allows rolls to be inserted in the stand and extracted by crane with increased safety and convenience.



Roll Changing Device

It had been the practice to sling from the crane hook a counterbalanced pick-up beam which had at its front end an adaptor socket into which the roll end could be inserted. The beam had to be supported by the sling under the combined centre of gravity. A series of ridges was welded to its underside to prevent the rope slipping off. Difficulties were experienced owing to the tendency of the rope to twist, moreover it was not easy to obtain accurate balance, so that there was a danger that the roll would tilt and slip out of its socket.

The device was subsequently improved, as shown in our illustration, by the provision of a notched bracket at the top, giving a finer adjustment and a more stable state of balance. Twisting of the rope is eliminated by slinging from a double hook which rotates on a ball thrust bearing.

The new method, which is claimed to have approximately trebled the speed of changing rolls, is quoted in a recent issue of the firm's works journal as being one of numerous improvements suggested from the shop floor for which awards were made last year.

Soot Gun

For the removal of soot from oil-fired central heating boilers, the "Chockus" soot gun has been put on the market by Scan-Technic, Raadhuspladsen 16, Copenhagen V. The gun operates, while the boiler is working, by injecting a solution of sodium carbonate, which causes the sulphurous deposits to become detached from the metal, leaving the interior boiler and flue surfaces clean. The equipment comprises a spray injector gun with container for sodium carbonate, 1000mm and 650mm long extension tubes, a curved tube (or flexible hose) fitted with couplings, rubber hose, atomising nozzle and bushings. The container of the gun is fitted with sodium carbonate, the rubber hose is connected to an existing water supply and the spray gun is ready for use. One charge is stated to be sufficient for one hour's work.

Tagus Bridge

The contract for the construction of the bridge over the Tagus at Lisbon has been awarded to an American group consisting of United States Steel Export Company, Morrison-Knudsen Company Inc., D. B. Steinmann, Tudor Engineering Company, and two Portuguese firms, Sorefama and Compadec. The contract is for 1760 million escudos (about £25,000,000).

THE AMERICAN SCENE

by Our American Editor

American Nuclear Congress and Atomic Exposition

No. III—(*Continued from page* 996, *June* 10)

The 1960 *Nuclear Congress and the sixth International Atomic Exposition were held at the New York Coliseum from April* 4 *to* 7 *; the congress was organised under the sponsorship of the Engineers' Joint Council in co-operation with twenty-eight American and Canadian engineering institutions. The exhibition was sponsored by the Atomic Industrial Forum and presented a comprehensive picture of the current state of development in the application of atomic energy in American industry.*

THE 1960 NUCLEAR CONGRESS

IN addition to the International Atomic Exposition, the 1960 Nuclear Congress included a two-day Seminar on Industrial Uses of Radioactive Isotopes. Also co-ordinated with the Congress programme were sessions of the Society of Automotive Engineers, on nuclear propulsion in aircraft. A total of sixty papers were on the technical programme of the Congress, and they covered seven major areas of interest in the atomic field. The papers were specially selected to deal with nuclear production problems which needed more clarification and study, and an effort was made to select papers which would not duplicate any technical papers presented at atomic conferences of the individual engineering institutions participating.

The 1960 Congress was able to report remarkable progress in the nuclear industry. According to the Atomic Industrial Forum, there are in the United States to-day eight nuclear power projects in operation, ten others under construction, eight under pre-construction development, and five more for which plans have been announced. In addition, there are eight American power reactor projects abroad. Three under construction are situated in Italy, Germany and Belgium. One, also in Italy, is under contract ; two, in Switzerland and Japan, are under contract negotiation; and two, in Italy and Cuba, are in the planning stage. The seven areas which the programme committee felt needed greater exploration at this Congress were as follows : reactor construction, reactor design, environment, materials and components, nuclear standards, isotopes, and radiation processing. All technical sessions of the Congress, as well as the opening general session on April 4, were held on the fourth floor of the Coliseum.

The Atomic Exposition included more than 100 exhibits from the U.S. and abroad. The displays offered covered such items as design engineering services, package power reactors, medical and research reactors, construction and fabrication techniques, control systems, reactor materials, instrumentation, particle accelerators, measuring instruments, laboratory equipment, fuel elements and other reactor components.

Curtiss-Wright Corporation

Several aluminium-clad plate fuel elements were exhibited at the stand of the Curtiss-Wright Corporation, Quehanna, Pennsylvania. This fuel element for research reactors is the culmination of two years of development efforts with an aluminium UO_2 cermet core in a water-cooled plate element. The development of a cermet core makes it possible to load more uranium into a given volume of compact. Therefore, for a core of a particular loading and plate thickness, it is possible substantially to increase the thickness of the aluminium cladding with a resultant increase in the durability of the core.

The cermet concept developed originally from the necessity of using 20 per cent enriched uranium in certain reactors in foreign countries. Since it was very difficult, using the alloy core method, to incorporate sufficient U-235 in an element, new techniques were sought, and the cermet design was the logical outgrowth. Curtiss-Wright has now adopted the cermet concept to highly enriched fuel and has developed an element with the following advantages :—Materials damage in the fuel plate due to fission is confined to the oxide particles and a thin shell surrounding each particle. Since the aluminium matrix is unaffected, the fuel core retains strength, even at high burn-up. Higher fuel loadings per unit volume are possible with the cermet core allowing either more fuel or thicker cladding for a plate of specified thickness. Powder metallurgy techniques developed by Curtiss-Wright facilitate an improved distribution and orientation of the fuel in the core. Finally, an exact determination of uranium loading is possible with the cermet technique.

The firm also displayed a variety of nuclear reactor components made of beryllium oxide. The Curtiss-Wright Corporation is now one of the leading American producers of fabricated beryllium oxide shapes. The products available range from massive blocks and cylinders fabricated by hot pressing to delicate, thin-walled tubes formed by extrusion and sintering. The element beryllium has outstanding nuclear properties which make it very attractive both as a moderator and as a reflector. The high-temperature properties of beryllium oxide, together with the fact that the cost per atom of the oxide form is somewhat less than that of the metallic form, make BeO particularly desirable for reactor components. Production quantities of several complex shapes have been successfully produced by the firm for the "Tory" reactor being constructed by the Lawrence Radiation Laboratory of the University of California. These parts are formed by hot pressing, followed by a sequency of machining operations to very close tolerances. Prototype fuel elements for several gas-cooled reactors such as the Marine Gas-Cooled Reactor have been produced from BeO with UO_2 or other nuclear fuels. These fuel elements are fabricated either by extrusion and sintering or by hot pressing.

Allis-Chalmers Manufacturing Company

The central display at the stand of the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, was a model of the boiling water reactor designed by the firm for the Rural Co-operative Power Association of Elk River, Minnesota, for operation with an existing conventional steam power station. When supplemented by a coal-fired superheater, the system will deliver steam to the turbine at 600 lb per square inch and 825 deg. Fah. An important feature of this 22MW(e) boiling water reactor is that by raising the water level in the core cavity and fuel storage well, spent fuel elements will always remain immersed during fuel transfer.

The reactor itself is rated 58·2MW(t) and is contained in a vessel about 7ft in diameter and 33ft long, with a wall thickness of 3in. The shell wall is made of carbon steel and is internally clad with a ¼in layer of stainless steel. The

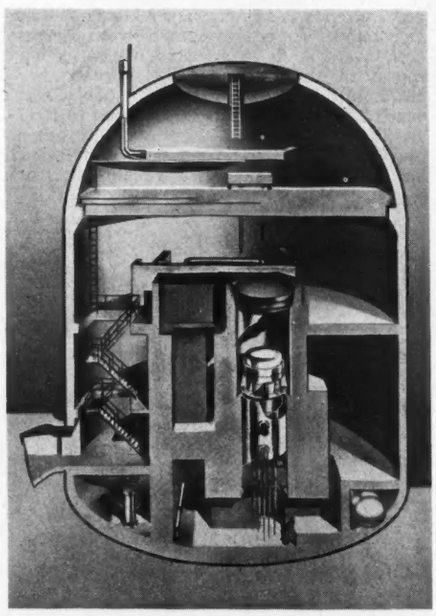


Fig. 17—Artist's impression of 58·2MW(t) boiling water reactor plant for the Elk River atomic power station in Minnesota

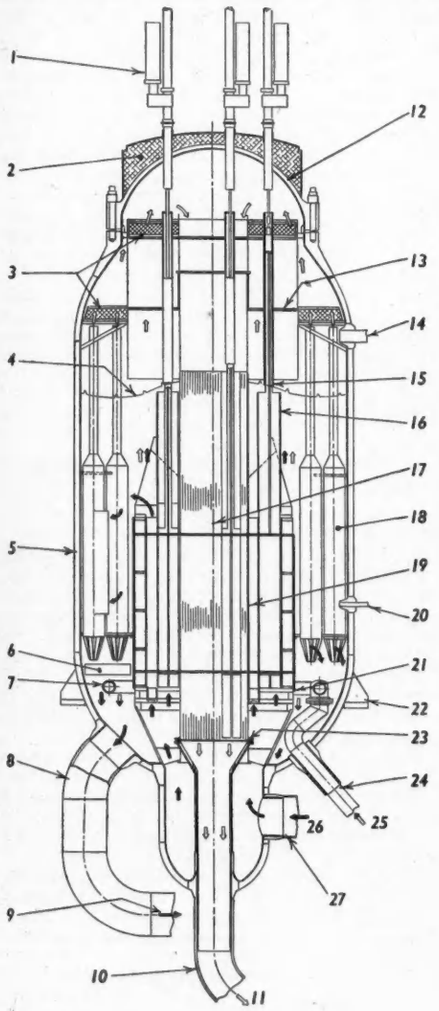
vessel was designed for pressures as high as 1250 lb per square inch, but will normally operate at about 900 lb per square inch. The start-up of the Elk River reactor is scheduled for late 1960, and various operator training programmes have been in effect since January. The courses conducted by Allis-Chalmers in Washington, D.C., include all subjects pertaining to the operation and maintenance of a nuclear facility. Three months' training experience in actual reactor operation follows at the E.B.W.R. facility in Lemont, Illinois.

Also exhibited was a model of the Allis-Chalmers "Pathfinder," a nuclear power station with a 62MW(e) direct-cycle boiling-water reactor. Situated near Sioux Falls, South Dakota, the project is the joint effort of eleven power companies in the midwest area in co-operation with the A.E.C. The Northern States Power Company is to operate the plant, which includes a controlled recirculation boiling-water reactor and uses a nuclear superheater. The core has two co-axial regions, with water being vapourised in the outer region and steam superheated in the inner region to a temperature well above that previously achieved in a nuclear reactor. The reactor operating pressure will be 600 lb per square inch gauge, the temperature of the boiler region will be 489 deg. Fah. and the

temperature of the superheater will be 825 deg. Fah. (See Fig. 18).

General Dynamics Corporation

The stand of the General Atomic Division of the General Dynamics Corporation, San Diego, California, stressed the firm's High Temperature, Gas-Cooled, Graphite-Moderated Reactor System (HTGR). This reactor concept was created when the Philadelphia Electric Company and fifty-one other utility companies responded to an invitation by the Atomic Energy Commission with a proposal to develop, design, build and operate a high-performance, gas-cooled nuclear power plant. The utility companies associated with Philadelphia Electric are members of High Temperature Reactor Development Associates, Incorporated, which is the largest and most widely representative group of utility companies to support a single atomic power project in the United States.



1—Control rod drives.
2—Thermal insulation.
3—Mist eliminator.
4—Liquid level.
5—Reactor vessel.
6—Neutron beam tube.
7—Feedwater distribution ring.
8—Recirculation water piping outlet (3 off).
9—486 deg. Fah., 620 lb per square inch absolute, 20,000 g.p.m. outlet.
10—Main steam line.
11—825 deg. Fah., 555 lb per square inch absolute, 619,000 lb per hour outlet.
12—Vessel head.
13—Steam baffle plate.
14—Liquid level column connection and thermocouple exit.
15—Control rods.
16—Control rod guide tubes.
17—Superheater region.
18—Steam separators.
19—Boiler region.
20—Liquid level column connection.
21—Boiler fuel support plate.
22—Vessel support lugs.
23—Superheater fuel support plate.
24—Feedwater pipe.
25—360 deg. Fah., 650 lb per square inch absolute inlet.
26—486 deg. Fah., 642 lb per square inch absolute inlet.
27—Recirculation water piping inlet (3).

Fig. 18—General arrangement of the boiling water reactor pressure vessel of a 62MW(e) "Pathfinder" atomic power station

The High Temperature, Gas-Cooled Power Reactor System is a compact high performance, high-temperature, graphite-moderated, helium-cooled reactor designed to use graphite-clad homogeneous fuel-moderator elements. The prototype plant for development, construction and operation on the system of the Philadelphia Electric Company has a designed output of 40MW(e), for which the reactor heat output is 115MW(t). General Dynamics will design and provide the nuclear steam supply system, including the reactor, while the Bechtel Corporation is the general contractor. Preliminary design work and evaluation studies already have extended well beyond the initial 40MW prototype plant, and include a plant as large as 325MW(e). Because of the high temperature of about 1380 deg. Fah. of the helium coolant from the reactor, the HTGR system is capable of producing steam at such modern steam turbine conditions as a pressure of 1450 lb per square inch absolute and a temperature of 1000 deg. Fah. The high coolant temperatures are possible because of the high allowable temperature of the graphite-body fuel elements.

The U-235 fuel and Th-232 fertile material, both in the form of carbides, are dispersed in a portion of the moderator and enclosed in a low-permeability graphite cladding. The reactor core is a cylinder 9ft in diameter and 7ft 6in high, comprised of 855 cylindrical control and fuel elements 3½in in diameter, arranged in a closely pitched equilateral triangular array. Approximately forty of these elements are control rods, arranged in a symmetrical pattern. The fuel elements are oriented vertically and the coolant gas passes through the passages formed by the elements. The bottom and top graphite reflectors, each 2ft thick, are made an integral part of the fuel elements. The side reflector, which extends the full height of the fuel elements, is also 2ft thick and is made up of a row of dummy graphite elements and a concentric graphite ring which encloses the core. The load of both the fuel elements and side reflector is carried by a 3in thick grid plate, which is reinforced by an egg-crate structure of sufficient strength to limit deflection. The core and reflector are effectively surrounded by a steel thermal shield. Incoming coolant gas flows along the pressure vessel wall and the thermal shield before passing up through the reactor core. A plenum chamber above the core, formed by a shroud which serves as a thermal barrier between the outgoing hot helium and the incoming cooler helium, is connected to the coolant outlet from the reactor.

The fuel-element design consists of a graphite can containing all the fuel compacts and a portion of both the top and bottom reflector, with the can encased in a graphite sleeve which is joined to the balance of the end reflector sections. Space provided between the graphite can and graphite sleeve will be purged by helium flowing through it and vented to a fission-product trapping system. Both the can and sleeve will be made of low-permeability graphite, which will limit the passage, on the one hand, of fission products from within the fuel can and, on the other hand, of helium into the interspace. Fission-product gas which does pass through the fuel can will be purged in the fission-product trapping system by a controlled inflow of helium.

The fuel compact is a homogeneous mixture of graphite, fuel and fertile material, with the fuel and fertile material in the form of carbides. The fuel compacts may be in the form of annular rings, inside which will be an additional graphite moderator with a small hole down its centre. A convective circulation path provided within the fuel can will allow fission products released from the fuel compacts to flow into the cooler region of the bottom reflector section of the fuel elements and into contact with the internal fission-product trap there. Carbides of uranium and thorium are used because at the operating temperature of the fuel they are thermodynamically stable. It is expected that a high fractional burn-up of the U-235 will be achieved; consequently, the fuel and fertile material are mixed to avoid a large change in power distribution during core burn-out. Additionally, the mixing of fuel and fertile material results in a useful contribution to the prompt negative temperature coefficient from a Doppler broadening of the thorium resonance. The composition of the fuel compacts is approximately 1 atom of U-235 to 10 atoms of thorium to 700 atoms of carbon. The particles of fuel and fertile material are dispersed in the compact so that the mean distance between particles is larger than the range of fission-fragment recoil. Hence, most of the graphite matrix of the fuel compact is free from fission-fragment damage.

The fuel elements are to be supported on a series of stand-off supports, arranged in a triangular pattern on the top surface of the grid plate. The supports will fit into recesses at the bottom of the fuel elements and form connection points for the fuel-element vent system. Leakage at these joints should always be in an inward direction, because the vent pressure will be maintained below that of the local coolant pressure. The spacing of the fuel elements is to be determined at their lower end by the grid plate and at their upper end by a slight enlargement in their outside diameter. This enlarged diameter corresponds to the pitch spacing of the fuel elements. During reactor operation, the fuel elements are forced together at these points of enlargement because the inner section of the side reflector is forced toward the centre of the reactor by the differential coolant pressure that exists between the face adjacent to the core and an outer vertical face.

In the HTGR, the approach is not to attempt a hermetic containment of all the fission products within the element, but rather to control their release in such a way as to avoid any major release into the primary circuit. In particular, the fission-product control system will serve (1) to limit the activity build-up in the primary-loop equipment from deposited fission-product solids to a level sufficiently low that fairly direct maintenance of the equipment can be performed, and (2) to limit the activity level of gaseous fission products in the primary helium coolant (*a*) so that accidental release of the coolant into the secondary containment will not result in a serious operational difficulty or hazard, and (*b*) so that continuous release of activity to the site surroundings due to normal coolant leakage does not exceed maximum permissible concentrations. Fission-product control starts in the fuel compacts, where about one-half of the fission-product elements formed can be expected to remain fixed, either because of their own non-volatility or because of their formation of stable, non-volatile carbides. The principal elements of this group are Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, La, Ce, Pr, Nd, and Pm. The remaining fission products diffuse more or less rapidly out of the fuel compact, depending on their volatility, and if not otherwise controlled, they would enter the primary coolant stream. The method proposed for the HTGR avoids this by providing a double, low-permeability graphite containment of the fuel compacts with the interspace between containers being continuously scavenged by a small fraction of the primary coolant flow which enters by way of a controlled in-leak. This helium purge stream will carry the fission products to an external fission-product trapping system, the purified helium being returned to the primary circuit. The principal advantage of this system over a by-pass system is that the chemically reactive or condensable fission products do not have an opportunity to plate out in the primary circuit prior to reaching the trap. In addition, the trap receives the fission products relatively undiluted, decreasing trapping difficulties. The connection of the purge stream from the fuel elements to the external trapping system would be made at the bottom support point of the elements.

The flow rate of the scavenging helium and the permeability of the outer graphite container or sleeve are to be selected to limit the back-diffusion of such fission products as Ba, Sr, Cs and I into the primary circuit to an amount consistent with the criterion of direct maintenance of the equipment. The scavenging flow can be at as much as 10^8 times that of the fission products without excessive demand on the flow capacity of a trapping system of reasonable size. With this flow and a contamination build-up limit of, say,

THE AMERICAN SCENE *(Continued)*

100 curies on the primary circuit surfaces a graphite with a permeability of 10^{-6} to 10^{-7} square centimetres per second (room-temperature permeability to helium) is adequate for the outer sleeve.

The inner graphite sleeve will serve to hold up fission products prior to their escape to the purged interspace and to the trap. This hold up allows the large energy release of the short half-life fission products to be given up in the element rather than in the trap, where it would result in a cooling problem. Also, the relatively tight inner sleeve encourages diffusion of the fission products in the active core region to the cooler bottom reflector, where all but the most volatile ones condense. The fuel compacts are designed to provide a path for fission products to flow and diffuse to the bottom reflector. This further reduces the escape of fission products to the external trap and also limits the pressure build-up in the inner can to essentially that caused by the noble gas fission products Kr and Xe. In the limiting case of a completely tight fuel can and total release of the noble gas fission products from the compacts, the end-of-life partial pressure of the fission products is about 10 atmospheres. This low pressure is the result of the homogeneous construction of the element with its associated voids, into which the gases can expand. In the event of loss of external coolant pressure, this 10 atmospheres of fission-product gases, plus a possible 20 atmospheres of helium in the inner can, is contained by the combined strength of the inner and outer can walls.

The scavenging helium flow will enter the interspace between the inner and outer graphite container by way of a porous graphite fitting at the top of the element. The fitting is designed to minimise back-diffusion of fission products through the incoming helium. The scavenging helium flow will leave the reactor through a network of tubes in the core support plate. The tubes are brought outside the reactor to the fission-product traps.

The control rods are operated from beneath the reactor and are inserted upward into the core to reduce reactivity. The top of the reactor is thus clear for ease of fuel-element handling. Three rod-motion energy sources are provided—pneumatic, hydraulic, and mechanical. To provide "fail-safe" operation, the control-rod drives are designed so that either pneumatic pressure or hydraulic pressure acting alone will scram the rod. During normal operation, hydraulic pressure will exert a net downward force to maintain the control-rod drive piston in contact with a stop which determines the control-rod position. The stop is positioned by an electric motor-driven, mechanically-operated, linear ball-screw actuator. To scram the rod, the hydraulic pressure is removed from the top of a differential-area piston, and an orifice in the discharge line limits the maximum control-rod velocity. The rapidly accelerated rod leaves the mechanical actuator behind, but the drive motor is simultaneously energised so that the mechanical actuator follows the control rods until all mechanical actuators have reached the fully-in position following scram action. Each rod may be used either as a shim or safety, and all rods scram regardless of their assigned functions. The control-rod poison is boron, dispersed uniformly as B_4C in a graphite matrix in the form of hollow cylinders. A control rod consists of a number of these cylindrical sections supported on a central cylindrical metal rod. The support rod is flexibly jointed to allow for any misalignment between the control rod and its actuating mechanism. Each control rod moves within a graphite guide tube similar in appearance to a fuel element except that the lower section extends into a recess in the grid plate.

A flow diagram of the primary coolant circuit and its auxiliaries is shown in the illustration, Fig. 19. The primary coolant cycle is a closed circuit which conducts the helium coolant from the reactor vessel outlet to a single steam generator, to the main circulators, and back to the reactor vessel inlet. The duct between the reactor vessel and the steam generator is made up of concentric pipes. The hot gas at 1380 deg. Fah. flows through the inner pipe to the steam generator and the cooled gas at 660 deg. Fah. returns to the reactor through the annular duct. The regenerative heating of the cool gas in the annular duct by the hot gas in the central line is reduced to a small effect by insulating the inner duct. One advantage of the concentric ducts is that the outer, pressure-bearing pipe is cool, whereas the inner pipe that carries the hot gas has only a small pressure differential applied to it. Also, the thermal stresses at the penetrations of the reactor vessel and steam generator are considerably reduced by the concentric pipe.

In passing through the steam generator, the hot coolant gives up its heat to make 367,000 lb per hour of 1000 deg. Fah., 1450 lb per square inch superheated steam and leaves the generator at 630 deg. Fah. The coolant then passes through the helium circulators and an outer shell within the steam generator and returns to the reactor vessel through the outer annulus of the concentric duct. Since concentric flow of the hot and cold helium coolant is used throughout the plant, all pressure-containing surfaces, including the reactor vessel, are exposed only to the low-temperature coolant. Hence, carbon steel may be used for most of the structural parts.

Two circulators are used in series to circulate helium through the coolant loop. These are canned-motor, single-stage, centrifugal compressors with overhung impellers. The compressor motor assembly is completely enclosed within a sealed can to prevent helium leakage. Cleaned helium fed to a labyrinth shaft seal prevents contaminated helium from entering the motor compartment. To facilitate isolation of the steam generator from the reactor, a specially designed concentric gate valve is installed in the concentric piping run. This valve is required only to stop flow through the concentric ducts by sealing tightly against the outer, cooler duct, since some flow between the inner pipe and the outer annulus on either side of the isolation point is of no concern. Consequently, the valve body service is limited to that of 660 deg. Fah. operation. Ports in the follower plates permit a separated flow of inner and outer gas streams when the valves are open.

Approximately 10,000 cubic feet of helium are contained in the primary coolant system, which consists of the reactor, steam generator, circulators and associated piping. Helium storage tanks are provided in the containment vessel. A vacuum pump and compressor are provided to transfer helium between the primary and the storage systems. Evacuated in normal operation, the storage tanks provide a surge volume for the relief of high pressure in the primary system. Rapid reduction of pressure by about 25 per cent is obtained by opening the dump valve, thereby equalising the pressures between the primary system and the storage tanks. A further reduction of system pressure is obtained by pumping from the primary system into the storage tanks. Continuous by-pass purification of the helium in the primary system is provided to maintain minimum equilibrium impurity levels. It is anticipated that total impurity levels of less than 10 p.p.m. will be necessitated by mass-transfer considerations.

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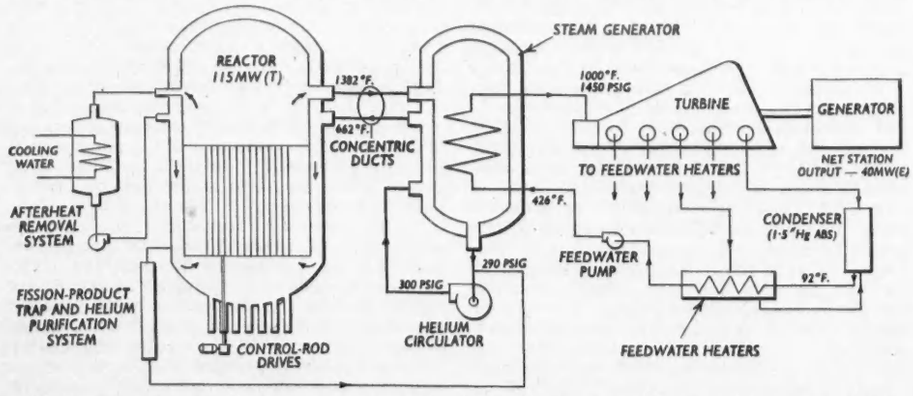


Fig. 19—Flow diagram of primary coolant circuit with auxiliaries of the High-Temperature Gas Cooled Power Reactor

New Piezoelectric Compounds

The discovery that zinc oxide and cadmium sulfide are strongly piezoelectric has been revealed by A. R. Hutson of Bell Telephone Laboratories, in the current issue of Physical Review Letters, a publication of the American Physical Society. To demonstrate the piezoelectricity in zinc oxide, it first had to be "doped" with lithium to neutraise the excess conductivity which has masked the effect till now.

The degree of piezoelectricity exhibited by the doped zinc oxide is about four times as great as that of quartz, while the cadmium sulfide is twice as great. Confirming measurements were made on single crystals of zinc oxide grown both by vapour techniques and from a flux.

In piezoelectric materials, the application of a mechanical stress results in the generation of an electrostatic charge. Conversely, when an electrical field is applied to such a crystal, its physical shape changes in a manner dependent on the way in which it is cut. A radio frequency electrical signal can thus be applied to a piezoelectric crystal to generate mechanical vibrations at the same frequency.

Both zinc oxide and cadmium sulfide have long been recognised as n-type semiconductors. Dr. Hutson decided to investigate the piezoelectric constants of these materials while studying some of their unusual conductivity properties, especially the large magnitude and temperature dependence of the phonon-drag effect observed in thermoelectric power measurements. A large piezoelectric constant seemed to explain these anomolies theoretically, but had never been observed experimentally.

The conductivity of the zinc oxide was "quenched" by diffusing lithium atoms into the material, to act as acceptors for the excess electrons which were contributing to the conductivity. When this was done, the resistivity of the material was raised from 10^3 to 10^{12} ohm-cm at room temperature.

Resonance-antiresonance measurements and direct squeeze measurements were made on vapour-phase grown needles and flux-grown platelets of zinc oxide, and on the vapour-phase grown cadmium sulfide. With dielectric constants of 8·2 and 9 for ZnO and CdS respectively, electromechanical coupling coefficients were calculated to be approximately 0·4 for ZnO and 0·2 for CdS, compared with 0·095 for quartz.

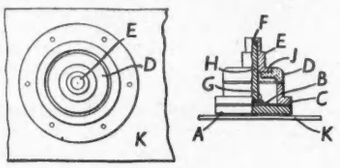
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

ELECTRONICS

835,993. May 23, 1955.—RECTIFIERS EMPLOYING SEMICONDUCTORS, The British Thomson-Houston Company Ltd., Crown House, Aldwych, London, W.C.2. (*Inventor: Alan John Blundell.*)

This invention relates to electric rectifiers employing a semiconductor body containing a p-n junction as the rectifying element. In constructing electric rectifiers of the above type, it is essential, *inter alia*, to provide the rectifying element with an hermetically sealed casing to obviate the deleterious effects of atmospheric conditions on the rectifying



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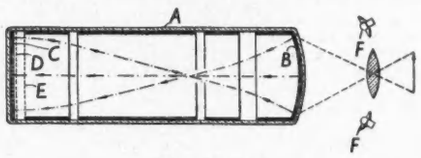
element ; to ensure that an undue rise in temperature of the rectifying element does not occur either during manufacture or operation ; and to reduce to a minimum the number of sealing points required in constructing the enclosing envelope for the element. It is the object of the invention to provide a construction of electric rectifier which will satisfy these desiderata. Referring to the plan view and sectional elevation, there is shown the rectifier as consisting of a baseplate or member *A* of metal of high thermal and electrical conductivity, e.g. copper, to which the rectifying element *B* is attached. The base member has secured to it a flanged metal annulus *C*, to the upper rim of which is hermetically secured an insulating member *D*. The member *D* is shown as formed with an internal shoulder into which seats the flanged portion of a metal sleeve *E* provided with a blind hole or recess *F*. The base member *A*, metal annulus *C*, insulating member *D* and metal sleeve *E* together form an hermetic enclosure for the rectifying element *B*. The rectifying junction in element *B* is formed by fusing a pellet *G* of impurity element of one conductivity type to a semiconductor body of opposite conductivity type, which pellet is connected with a co-operating electrode *H* in the form of a metal rod which terminates in recess *F* in sleeve *E*. The insulating member *D* may be of glass or ceramic material. When formed of ceramic material, as is preferable, it is provided with a shoulder *J* on to which the rim of the metal sleeve *E* fits, the rim of the sleeve being secured to the ceramic member by means of a solder which unites with it and with a metallic film, previously provided on the surface of the shoulder on the ceramic member. The ceramic member is then similarly united to the metal annulus *C*. When glass is employed in place of ceramic material, the glass is hermetically sealed by fusion to the metal annulus and to the metal sleeve, the glass and metal being chosen to have a thermal expansion characteristic comparable with that of the metal members to which it is secured, and the metals being selected to form a hermetic joint with the glass. During operation, it is desirable to ensure that the heat developed by the passage of rectified current through the rectifier element does not cause undue heating of the element, and the metal base is accordingly made of a metal of good thermal conductivity, and is of sufficient thickness to remove by conduction, the heat developed at the rectifying element. To ensure that the heat so removed is dissipated, there may be provided, in intimate contact with the metal base, a radiating fin *K* of large surface area, secured in intimate contact with the metal base. This may be effected by means of a low melting point solder or alternative damping means, illustrated in the specification, may be employed.—*June* 1, 1960.

836,229. January 30, 1958.—ELECTRON DISCHARGE TUBES, English Electric Valve Company, Ltd., Queens House, Kingsway, London, W.C.2. (*Inventor: George Baldwin Banks.*)

The object of this invention is to provide improved and relatively simple electron discharge tubes which will store optical images and reproduce them for direct viewing and which employ the same electron source both for storing and reproduction. The drawing shows a tube comprising an approximately cylindrical envelope *A* having a photo-cathode *B* on the inside of one end wall and a fluorescent screen *C* which is substantially parallel to the cathode on the inside of the other end wall. For storing a light image the image is focused on to the cathode *B* so that photo-electrons are emitted therefrom and are focused on to the storage grid *D*. The potential of the storage grid *D* is such that its insulating layer emits secondary electrons which are collected by the collector electrode *E* so that the insulation material on the storage grid acquires a positive charge pattern, the charges occurring at points where photo-electrons have landed. In this way a charge image corresponding to the original light image is produced on the insulation of the storage grid. When the stored image is to be displayed on the screen *C*, the photo-cathode *B* is uniformly illuminated by the light sources *F* so that there is a substantially uniform emission of photo-electrons from the whole cathode surface. The beam of photo-electrons thus constituted acts, in effect, as a viewing beam and under the influence of the potentials which are applied during this operation the photo-electrons reach the storage grid in a beam which is substantially uniform over the whole surface. The metal mesh of the storage grid is at zero or earth potential so that photo-electrons can penetrate the storage grid and proceed towards the screen *C* only at those points where the insulating coating has received a positive



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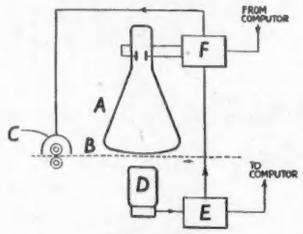
charge during the previous image storing operation but at other points the photo-electrons are turned back and taken up by the collector grid. The electrons which pass the storage grid are accelerated to the fluorescent screen by the very high positive potential thereon and the stored image is visibly reproduced by the screen with substantial intensification as compared with the original image, this intensification being obtained by virtue of the integration of stored charge on the storage grid during the storage period and by virtue of the high potential on the fluorescent screen during the viewing period. A stored image reproduced in this way on the screen will persist for some time—indeed until positive ions due to residual gas in the tube cause the whole of the storage grid to become charged. To erase a picture a positive pulse is applied to the collector grid when the light sources *F* are switched on, thus causing the collector grid to collect a negative charge from the viewing beam and preventing any further penetration by the electrons of that beam. The sequence of storing and viewing operations can proceed indefinitely and if repeated in succession at a frequency above that of persistence of vision will result in effectively continuous image presentation on the screen.—*June* 1, 1960.

835,543. May 18, 1956.—TAPE READER MECHANISMS, Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1-3 St. Paul's Churchyard, London, E.C.4. (*Inventors : James Hargreaves Woodcock Taylor and John Cecil Gladman.*)

This invention relates to tape reader mechanisms for digital data, the information being stored by apertures punched in the tape. Its main object is to provide an improved mechanism permitting a high speed of operation combined with high flexibility. Referring to the drawing, *A* represents the cathode-ray tube and *B* the tape which is moved across the face of the tube by a tape drive *C*. Light from the cathode-ray tube passes through the apertures in the tape on to a light sensitive cell *D*. The output from the light sensitive cell passes to control apparatus *E* from which the information is fed to the computer during each transverse scan. At the same time the control circuit operates on a deflection circuit *F* in such a manner that the beam of the cathode-ray tube is deflected to ensure that the light spot remains locked on to a control aperture in the tape. The deflection voltage produced in the deflection circuit to effect this locking is applied to the tape drive. When a trigger signal is received from the computer a temporary deflection voltage is applied to the cathode-ray tube which causes the light spot to jump on to the next control aperture where it is locked by the control circuit acting on the deflection circuit as above described. This action will deflect the light spot from its normal position of rest and the control exerted on the tape drive will be such as to tend to move the tape so as to return the aperture on to which the light spot has locked, and hence the light spot, to its normal position. This will move the tape forward. Thus each time a signal is received from the computer the light spot is moved by one line. If, therefore, the



No. 835,543

rate at which signals are received is low the control signal applied to the tape drive will be small as the light spot will only have been deflected a small distance from its position of rest and the tape will be moved slowly. If, on the other hand, trigger signals are received at a high rate of repetition the light spot will be deflected an appreciable distance as the rate at which the drive can accelerate is limited. A strong control signal will hence be applied to the tape drive and it will move the tape more rapidly.—*May* 25, 1960.

ELECTRIC TRACTION

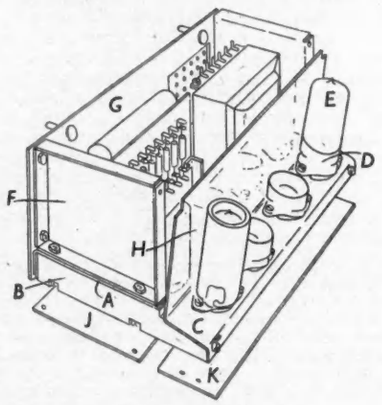
836,130. November 4, 1955.—CONTROL OF ELECTRIC TRACTION MOTORS, Société Générale de Constructions Electriques et Mécaniques (Alsthom), 38, Avenue Kléber, Paris, France.

The present invention is designed to reduce the susceptibility to wheel slip of electric traction vehicles equipped with motors having series excitation and, in some cases, rheostatic starting. The invention consists in shunting the armature of the traction motor or motors by resistances of value materially greater than that of the resistance of the armature or armatures which they shunt, this shunting being applied at least for those starting notches on which wheel slip is particularly likely to develop. No special relay or automatic control arrangement is therefore required. The addition of the armature shunt resistance evidently brings about a certain loss of energy and an increase in the total volume of the resistances of the equipment; but it suffices to shunt a relatively small current with respect to the current in the armature (a tenth for example) in order to obtain a very substantial reduction in the slope of the effort/speed characteristic and in consequence notably to improve the adhesion of the vehicle. The invention may be applied to an alternating current supply system or where the supply is direct current. In the case of a single-phase series commutator motor, the shunting of the assembly consisting of the armature, commutation windings and compensating windings, is fundamentally inadmissible, for it would introduce a harmful deregulation of the component of the flux emitted by the commutating poles which should neutralise the static voltage induced in the sections of the armature in communication with the alternating field flux. In this case the entire motor (that is to say armature, commutation windings, possible compensation windings and field windings) would be shunted by the resistance. In the case of a series motor fed with rectified current, the shunting of the armature associated with its commutation windings and (possibly) compensation windings presents no inconvenience; on the contrary, this shunting by a pure resistance, the admittance of which is very large with respect to that of the armature branch, has the effect of reducing the extent of fluctuation of the current in the armature and consequently of facilitating commutation during the high current starting periods. Typical control schemes are illustrated in the specification and show how various sections of the normal starting resistance may be switched during acceleration to vary the value of the armature shunt on successive notches of the master controller. Where pairs of motors are connected permanently in parallel, as in 3000V d.c. traction equipments, individual shunts across the armatures are preferred. An application to a diesel-electric locomotive is also illustrated.—*June* 1, 1960.

TELECOMMUNICATIONS

836,405. January 11, 1956.—MOUNTING ARRANGEMENTS FOR ELECTRICAL COMPONENTS, Automatic Telephone and Electric Company Ltd., Strowger Works, Liverpool, 7 (*Inventor: Joseph Bernard McCusker.*)

In modern multi-channel carrier telephone systems the equipment is developed on a functional unit basis and comprises a large number of relatively small box-like units, each containing a compact arrangement of the internal components. This form of construction produces a high density of components for a given volume, but as a proportion of these components are hot-cathode tubes the problem of heat dissipation is of prime importance. The object of the present invention is to provide a mounting arrangement, which, while maintaining the feature of high density of components, enables the heat generated by the hot cathode tubes to be



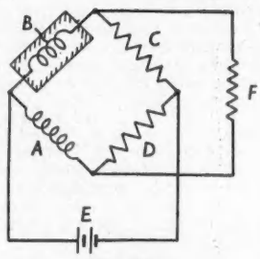
No. 836,405

dissipated in such a way that it is directed away from the rest of the components, some of which would be adversely affected by it. From the drawing, which shows a typical unit of carrier telephone equipment, it will be seen that a main chassis *A*, on which is mounted a majority of the components, has attached to it by side members, a sub-chassis *C* which carries the tube holders *D* and tubes *E*, the necessary connecting leads being extended to the valve holders from the main chassis. The sub-chassis is mounted at an angle in relation to the main chassis. The side members *B*, which connect the two chassis together, are made of a material which is a poor conductor of heat such as a synthetic resin bonded fibre, thereby ensuring a minimum of heat conduction between the chassis. The main chassis has at each end a flanged rectangular plate *F* to which is secured a front panel *G* and an "L"-shaped cover plate (not shown). Between this cover and a vertical extension *H* of the sub-chassis there is a gap which provides a thermal barrier of air, which is, of course, a relatively poor heat conductor and as the gap is extended through the base cover plates *J* and *K* a cooling current of air is allowed to rise between the hot and cold sections of the unit. In addition, the surface of the extension *H* which is nearest to the tubes is highly polished, providing a large surface area from which the heat of the tubes is reflected, thereby assisting the dissipation of this heat and directing it away from the main chassis. The invention is not limited to carrier telephone equipment but is applicable to equipment where the heat generated by thermionic tubes may produce undesirable effects in other components. —*June* 1, 1960.

INSTRUMENTATION

835,551. April 26, 1956.—TEMPERATURE MEASURING DEVICES, The English Electric Company, Ltd., Queens House, 28 Kingsway, London, W.C.2. (*Inventor : Charles Peter Gratton.*)

In automatic temperature control systems it is frequently required to produce an electrical signal which is proportional to the rate of change of a particular temperature. One method used for obtaining such signals entails the use of a damping transformer in conjunction with a magnetic amplifier. There are two serious limitations to this method ; first, for very slow rates of change of temperature the transformer must be large, and secondly, at low power levels zero drift in the amplifier is serious. A need, therefore, exists for a device which will give sufficient power output at low rates of temperature change to overcome zero drift problems in the magnetic amplifier. According to this invention, a temperature measuring device comprises a bridge network of which two arms are formed by resistance thermometers (see drawing). The device comprises a rapid response thermometer *A*, a slow response thermometer *B*, and balancing arms formed by resistors *C* and D. An energising signal is applied between the junctions of *A* and *B*, and the junctions of *C* and *D*. This energising signal is depicted schematically by the battery *E*. The output signal from the bridge is obtained from the junctions between the thermometers and the resistors and is shown to be supplied to the load *F*. In operation, when the thermometers are subjected to the same rate of change of temperature the rapid response thermometer will respond quickly to the change in temperature whereas the slow response thermometer will have an inherent lag which



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will depend upon the rate of change of temperature. If the system is designed so that the network is balanced for all working values of temperature there will be zero output for a constant temperature and the output from the network will depend solely upon the rate of change of temperature. It will normally be desirable for the output signal to be closely proportional to this rate of change of temperature over a wide range of temperature variation and in this case it may be necessary to lose the potential sensitivity of the bridge network and design the network so that *C* and *D* are both much greater than *A* or *B*. If the resistance thermometers have elements composed of the same materials then it will be necessary in the case of the simple network arrangement shown in the drawing to cause them to have identical characteristics in order to ensure that the output signal is dependent only upon the rate of change of temperature variation. However, it is not necessary that the thermometers should be identical so far as their resistances are concerned. In practice the requirement for linearity between the output signal and the rate of change of temperature can only be obtained at the expense of sensitivity. A typical design is one in which $A = B = 4{\cdot}25 + 0{\cdot}0109\ T$ ohms, where T represents the temperature in degrees centigrade. Typical time constants are one minute and five minutes for *A* and *B* respectively.—*May* 25, 1960.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

THIMBLES FOR NATURAL FIBRE ROPES

No. 3226 : 1960. Price 4s. This publication deals with the materials and dimensions for thimbles for natural fibre rope over a size range from ¾in to 18in. These thimbles may be made from crescent-shaped rolled steel bar, or they may be forged, and in the publication requirements are specified for the steel in both instances.

Unless otherwise ordered, the thimbles are to be "hot dip" galvanised, and all surface areas are required to be free from roughness and sharp edges. In the specification dimensions, including appropriate tolerances, are presented in association with a full-page diagram.

KEROSENE (PARAFFIN) UNFLUED SPACE HEATERS COOKING AND BOILING APPLIANCES FOR DOMESTIC USE

No. 3300 : 1960. Price 10s. This new standard supersedes the one issued in 1953 as B.S. 2049, Part 1. Its publication so rapidly on the heels of the recent D.S.I.R. report on oil heaters, represents the determined efforts of the British Standards Institution, heater manufacturers, Government departments and safety interests to get out a new, safe specification in the shortest time possible. The main feature of the new British Standard is the inclusion of a really severe draught test. Tests will have to be made by manufacturers—with the aid of a wind-tunnel—to ensure that heaters will not create a fire hazard even when exposed to draughts up to as strong as 26ft a second, that is, 17 to 18 m.p.h. This figure was recommended by the D.S.I.R. in its recent report. The standard also includes a requirement to limit as much as practicable the hazard which might result should an appliance be knocked over. Makers are called upon to overturn lighted heaters and then, scientifically, to measure the degree of burning that occurs—if any. The fuel tanks of radiant heaters must be made of corrosion-resistant materials because a fuel tank that corrodes is a potential fire risk. The standard lays down that all heaters must include some provision for fixing them to the floor or wall to prevent overturning. This requirement is designed especially as a safeguard for children. Other amendments have been made to bring this new standard fully up-to-date, and to make oil appliances generally more efficient and safer.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., June 20.—BRISTOL AND WEST OF ENGLAND BRANCH : Grand Hotel, Bristol, Annual General Meeting, 7.45 p.m.
Thurs., June 23.—SOUTH LONDON BRANCH : Greyhound Hotel, High Street, Croydon, Surrey, "Heat Storage," R. Jackson, 8 p.m.
Fri., June 24.—COVENTRY AND DISTRICT BRANCH : E.M.E.B. Sports and Social Club, Merrick Lodge, Sandy Lane, Coventry, Films on "Installing Armoured Cables," 7.45 p.m.

BRITISH INSTITUTE OF MANAGEMENT

Wed., July 20.—Connaught Rooms, London, W.C.2, One-day conference on "A Practical Guide for Management Decisions," 9.45 a.m.

FEDERATION EUROPEENNE DE LA MANUTENTION

Mon., June 27 *to Sat., July* 2.—Stockholm, Sweden, Eighth Annual General Meeting.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., June 22.—Festival Theatre, Winter Gardens, Malvern Annual General Meeting, 9.15 a.m.

INSTITUTE OF METALS

Mon., July 25.—Royal Institution, Albemarle Street, London, W.1, "The Structure of Metals and Intermetallic Compounds," Linus Pauling, 6.30 p.m.

INSTITUTE OF PETROLEUM

Fri., June 24.—EXPLORATION AND PRODUCTION GROUP : 61, New Cavendish Street, London, W.1, A symposium on Exploration and Production Methods, "Geophysics To-day," J. McG. Bruckshaw ; "Possible Improvement in Drilling," H. D. Fanshawe ; "Advances in Well Logging," P. Threadgold ; "Partial Removal of H_2S from Crude Oil by Stripping with Natural Gas," T. R. Shipster, 10 a.m. and 2.30 p.m.

INSTITUTE OF SEWAGE PURIFICATION

Tues. to Fri., June 21 *to* 24.—Scarborough. Annual Conference.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., June 27 *to Fri., July* 1.—Summer Meeting in Scotland.
Thurs., June 23.—Royal Festival Hall, London, S.E.1, Conversazione, 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, June 17.—SOUTHERN BRANCH : Visit to The Metal Box Co., Ltd., West Road, Fishgate, Portslade, 5 p.m.
Sat., June 18.—AUTOMOBILE DIVISION : Motor Industry Research Association, Lindley, Nuneaton, 1960 Summer Gathering, 1 p.m. to 6 p.m.
Tues., June 28.—SOUTHERN BRANCH : Visit to the Paper Mills, Thatcham, 10 a.m.
Wed., June 29.—SOUTHERN BRANCH : Visit to H.M S "Sultan," Gosport, 9 45 a.m. to 4 p.m.
Wed. and Thurs., June 29 *and* 30.—INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP AND THE EDUCATION GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, Informal Discussion on "Machine Tools and the User," 6 p.m.

ROYAL METEOROLOGICAL SOCIETY

Wed., to Fri., June 29 *to July* 1.—Summer Meeting at Queen's College, Dundee.

Advanced Engineering Courses

Road Materials and Construction. ROAD RESEARCH LABORATORY, Harmondsworth. Courses will deal with the fundamental properties of road materials and with the results of research and their application in modern practice. The courses will be held as follows (concluding dates are approximate) : "Concrete," No. 31C, September 27 to October 6 ; No. 32C, October 11 to 20 ; "Bituminous (including Tar) Materials," No. 31B, October 25 to November 4 ; No. 32B, November 8 to 18 : "Soil Mechanics," No. 31A, November 22 to 29 ; No. 32A, December 6 to 13 ; "Tropical Roads," No. 3T, November 30 to December 2 ; No. 4T, December 14 to 16. The fee for each course will be twelve guineas.

Harwell Reactor Course for Europe. UNITED KINGDOM ATOMIC ENERGY AUTHORITY, 11, Charles II Street, London, S.W.1. The Harwell Reactor School is to hold a course for forty-eight technical executives from seventeen member countries of the Organisation for European Economic Co-operation from July 4 to 15. These include the six Euratom countries, the three Scandinavian countries, Austria, Greece, Iceland, Ireland, Portugal, Spain, Switzerland and the United Kingdom. For the first week, the course will be held at the Reactor School, Harwell. For the second week, it will be held at Durley Hall, Bournemouth, in order that the lecturers during that week can be drawn from the Atomic Energy Establishment, Winfrith. The course is designed to give senior executives who have a technical background an introduction to the principles and problems of nuclear science and engineering. They will also visit the Atomic Energy Research Establishment, Harwell, and the Atomic Energy Establishment, Winfrith. Lectures given during the course will cover technical and economic aspects of nuclear energy and, in particular, problems of physics, chemistry, electronics and metallurgy involved in the construction and operation of nuclear installations. A visit will be made to the Hinkley Point nuclear power station site.

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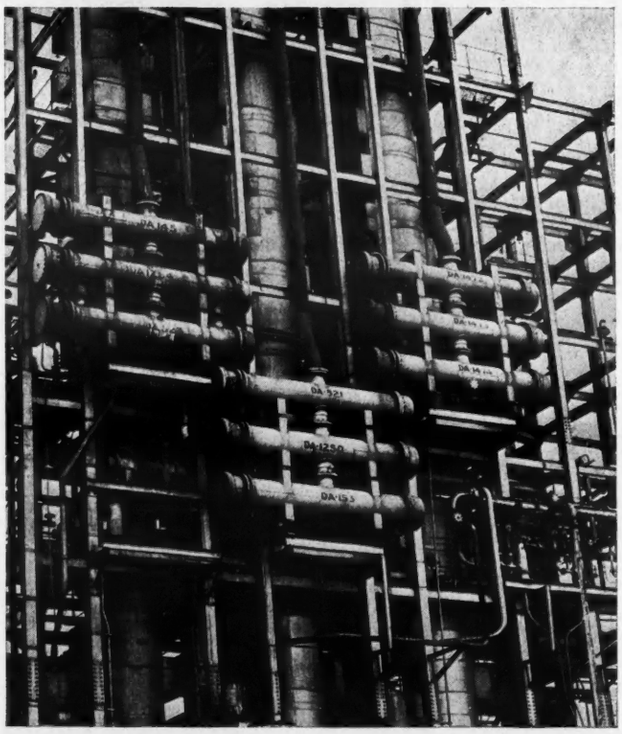

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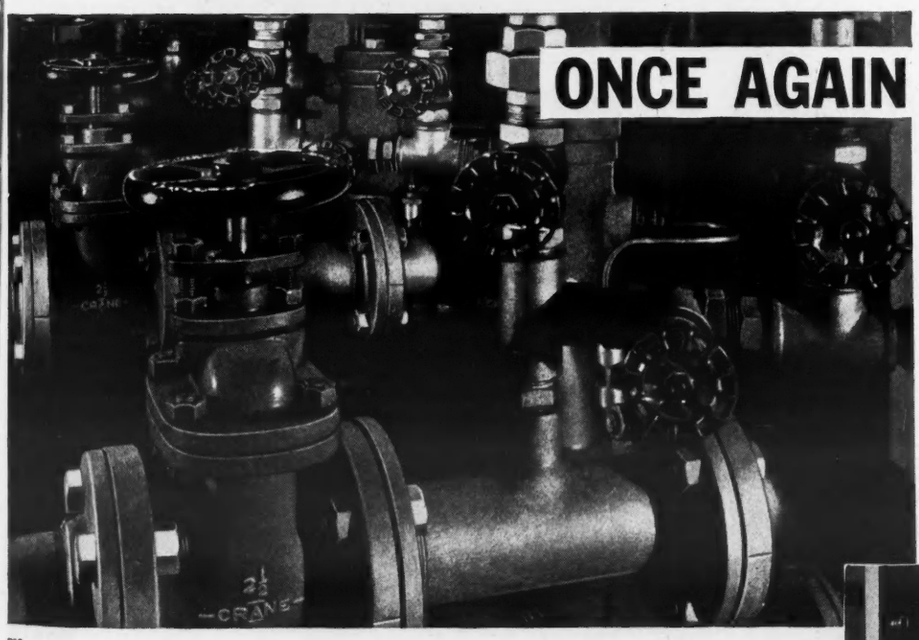

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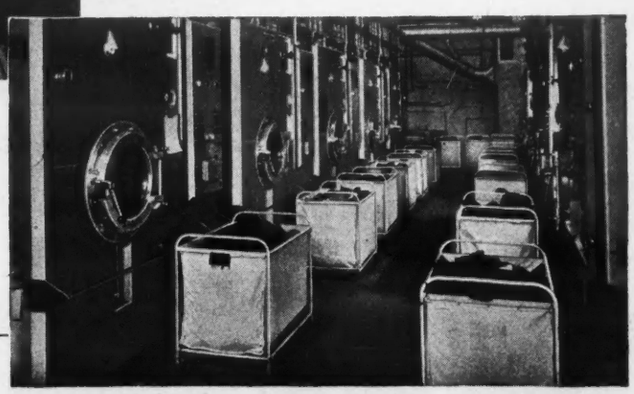

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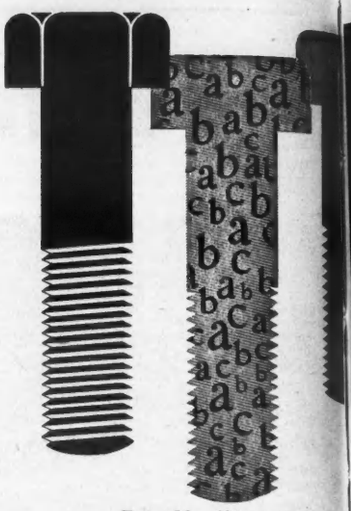

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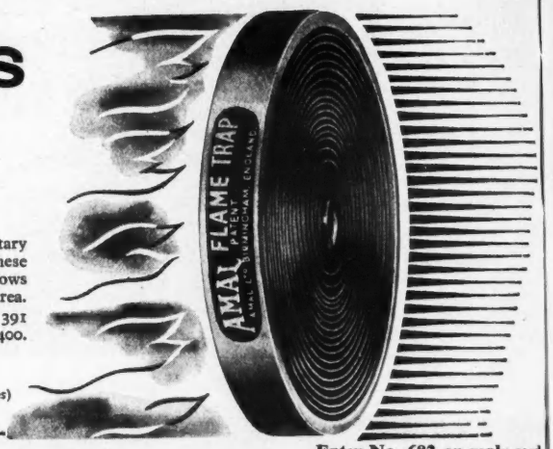

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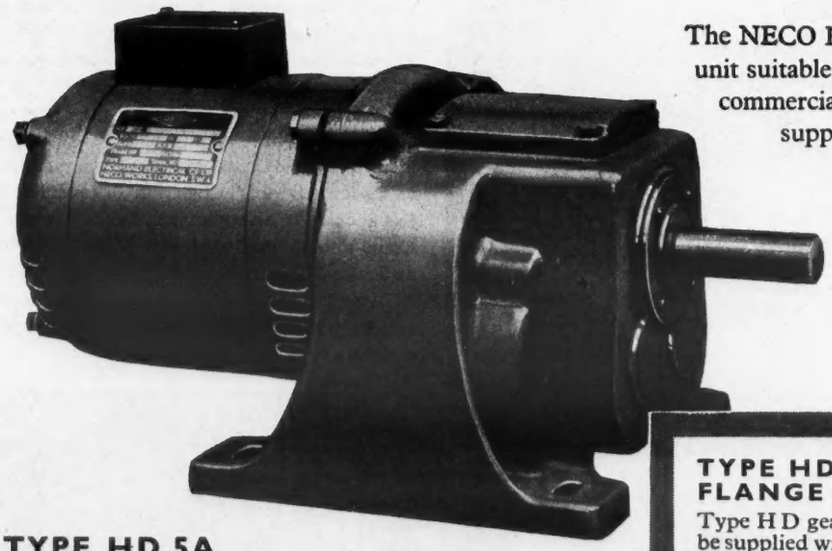
type H D geared motors



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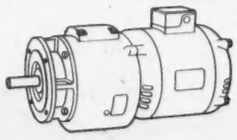

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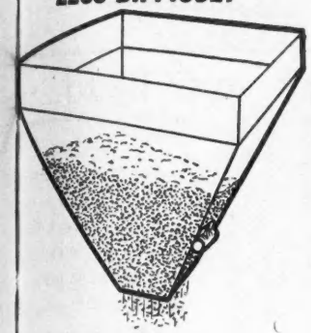

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trouble-free bunker discharge

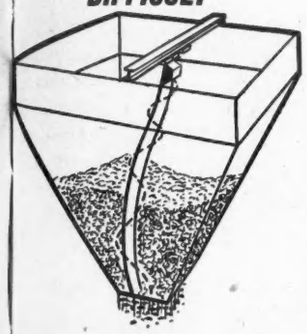
The primitive, inefficient method commonly used for clearing material which sticks in a storage bunker is by applying a sledge hammer to the side of the hopper. This is a form of low frequency, uncontrolled vibration. When vibration is applied at the *correct* frequency, the *correct* amplitude and the *correct* point of application, almost any material can be satisfactorily discharged.

SINEX has the experience with a wide variety of materials and a wide range of hopper designs to recommend how vibration should be applied effectively to solve *your* particular problem.

The three examples illustrated show three different combinations which are typical of many applications, but even these, whilst using the same type of unit, can only be effective if the types of unit themselves are placed in the correct position and have the correct frequencies and amplitudes of vibration to suit the characteristics of the material to be discharged.

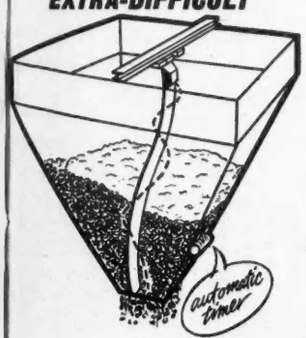
It would pay you, therefore, to make use of our experience and to consult us on your particular problem. Send for relevant details and information sheet.

DIFFICULT

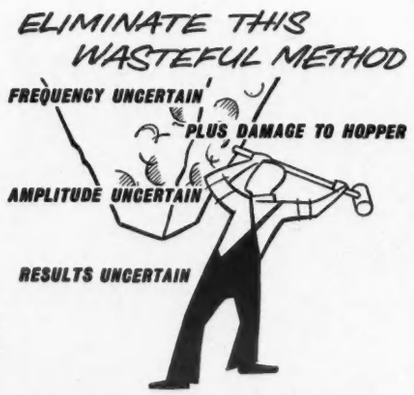


The vibrating reed for application where external vibration is impractical due to structural or other difficulties and if the bunker is made of concrete.

EXTRA-DIFFICULT



A combination of internal and external bunker vibration. Where the external vibrator is timed for 'on and off', the vibration frequency, on slowing down, goes through the natural resonance of the bunker, irrespective of load material contained.



These are some of the many materials which we have handled satisfactorily and ensure trouble-free bunker discharge : Pulverized and small coal, iron-ore, coke, lime, flour, grain, grist, foundry sand, soda ash, cullet, sand, gravel, granite chips and all road stone materials.

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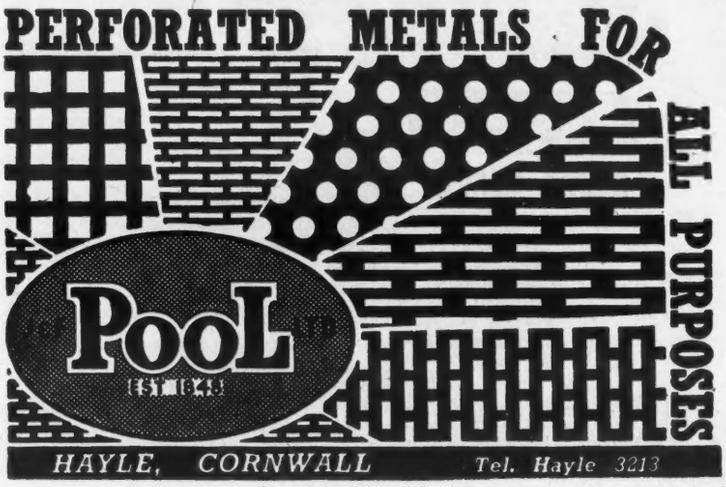

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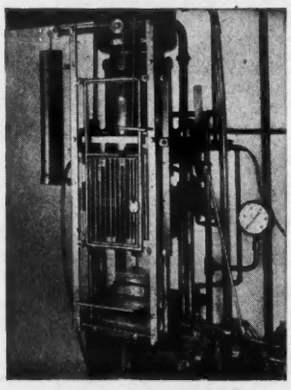

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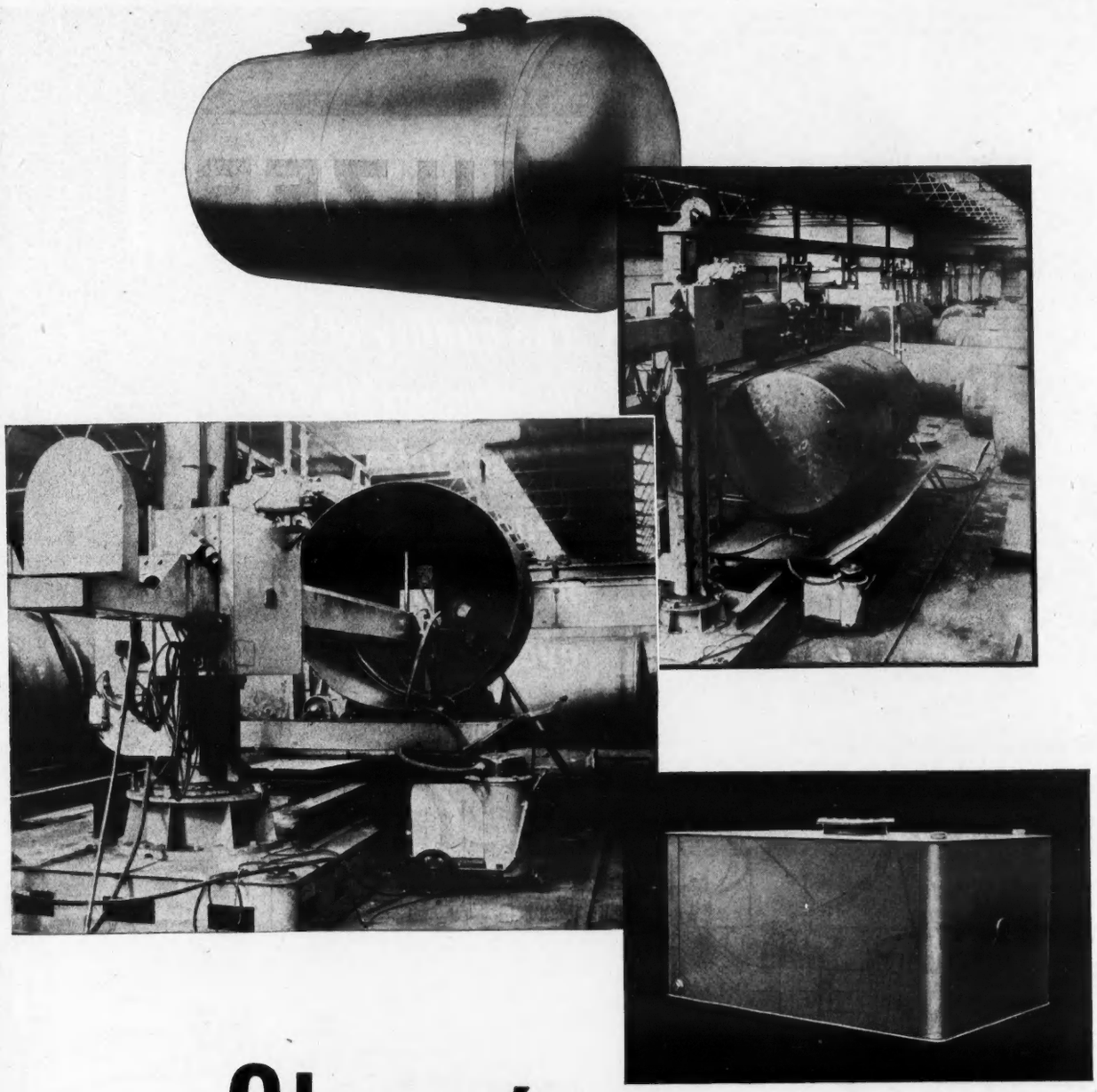

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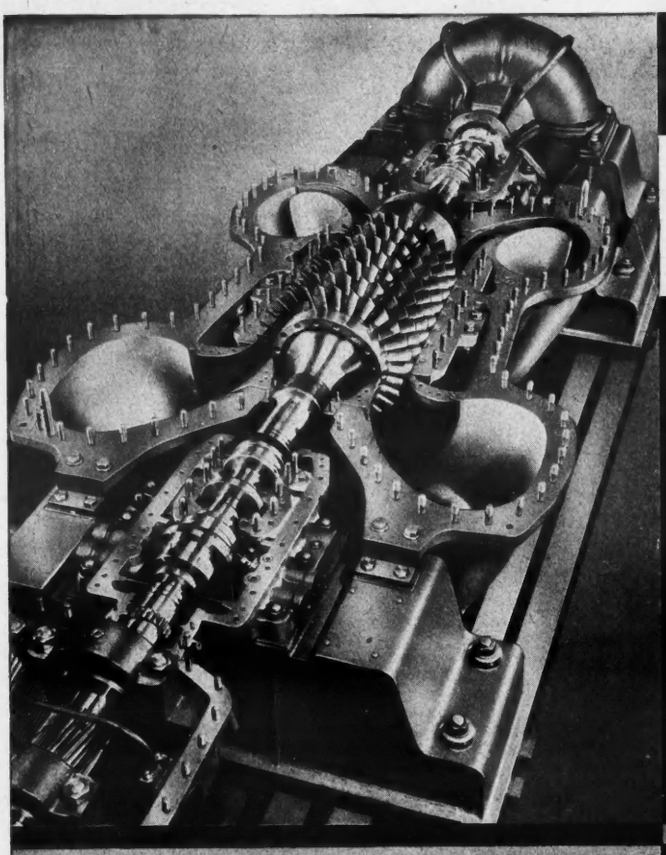

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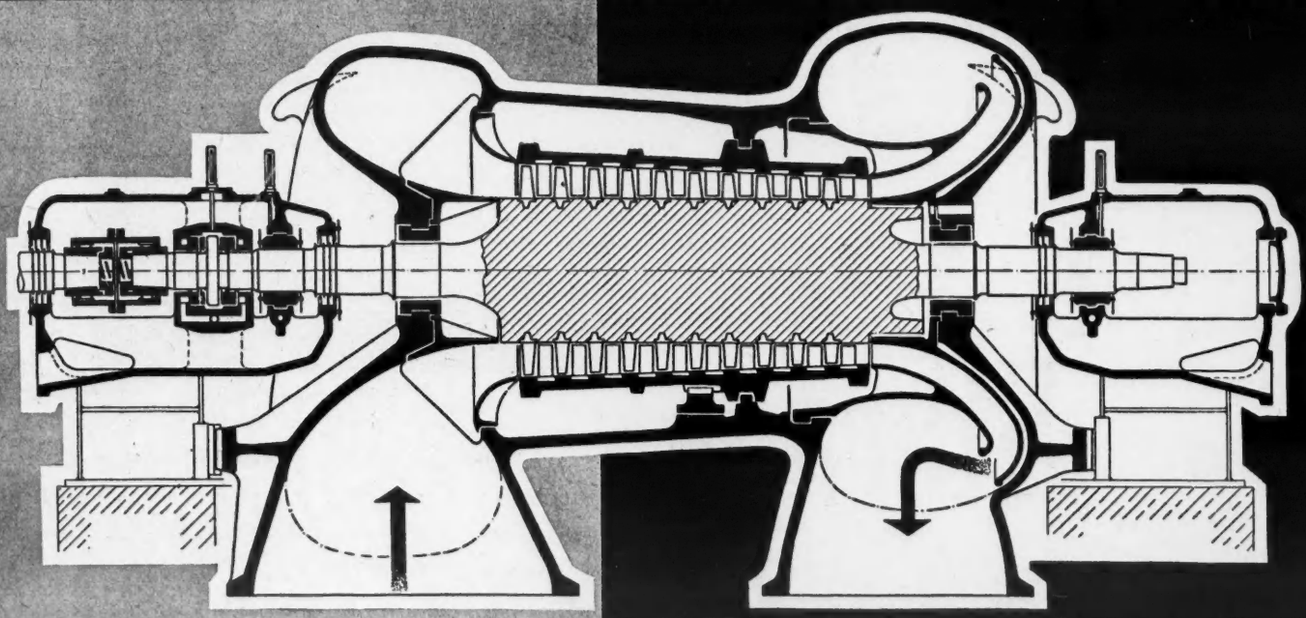

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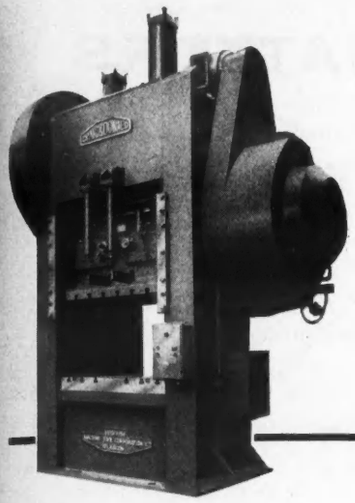

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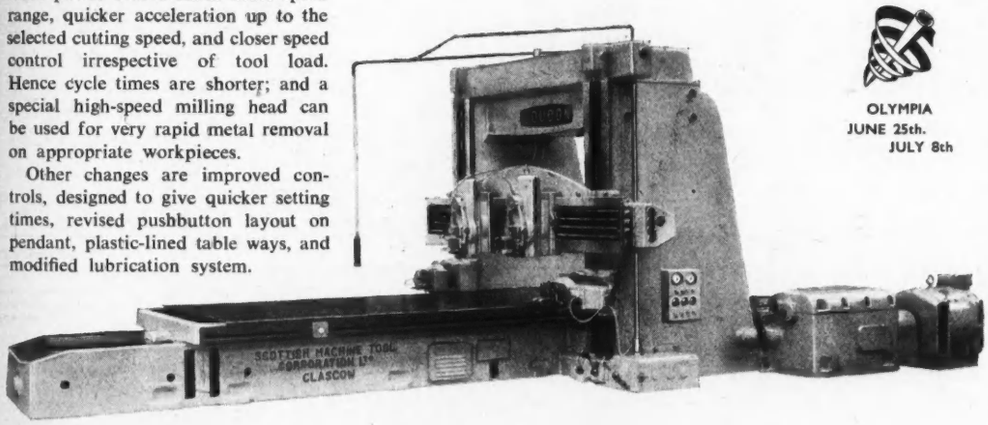

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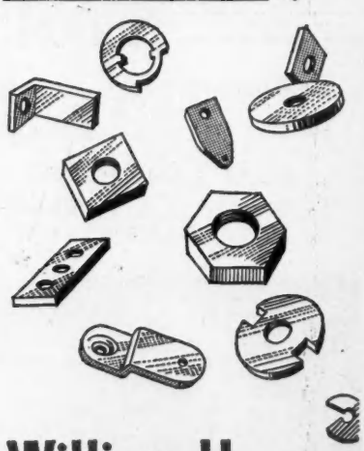

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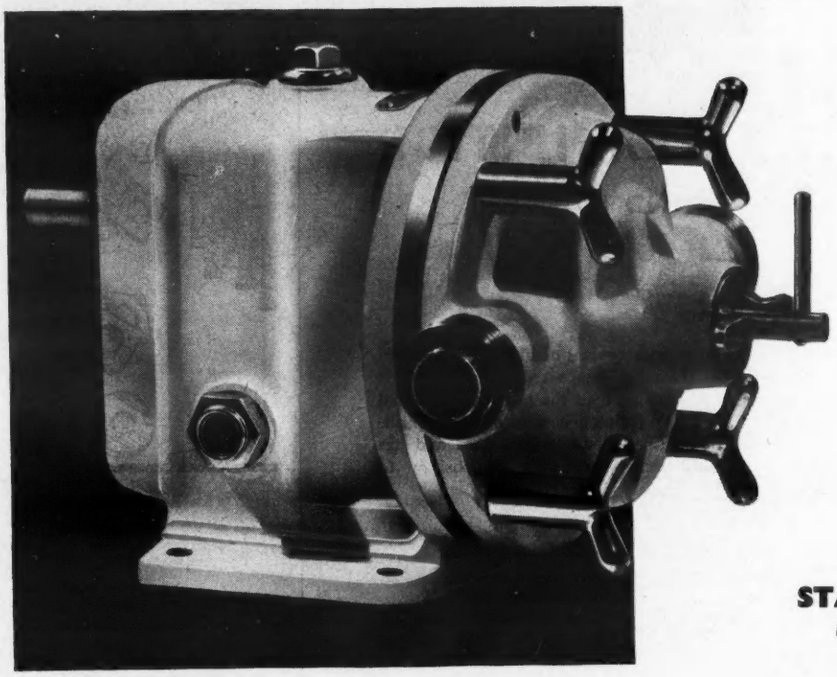

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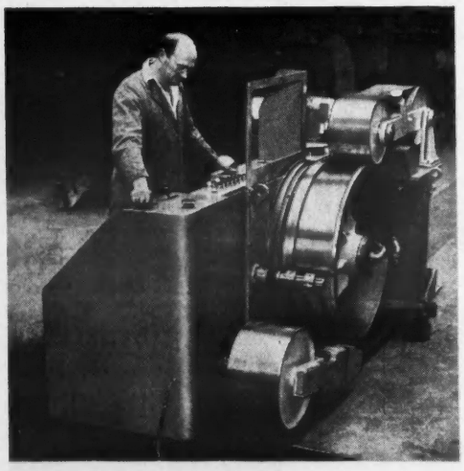

Continuous Casting Machine to produce 25' 0" per min. of 8" wide x ½" thick Aluminium. This machine is to form part of a complete line. The molten metal is poured into the cavity formed in the large revolving casting wheel and is held in position by an endless steel belt. As the wheel turns, water is sprayed on the inside and outside of the wheel and consequently solidifies the metal thus forming a continuous strip.

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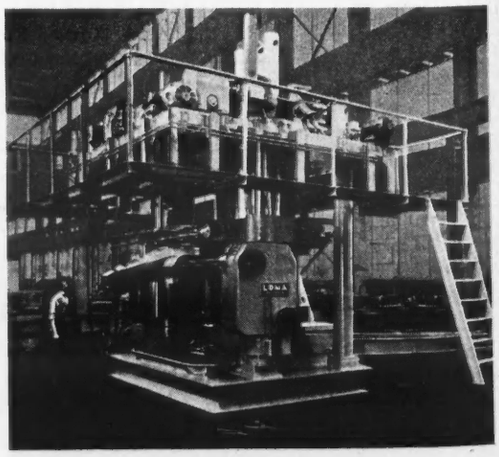

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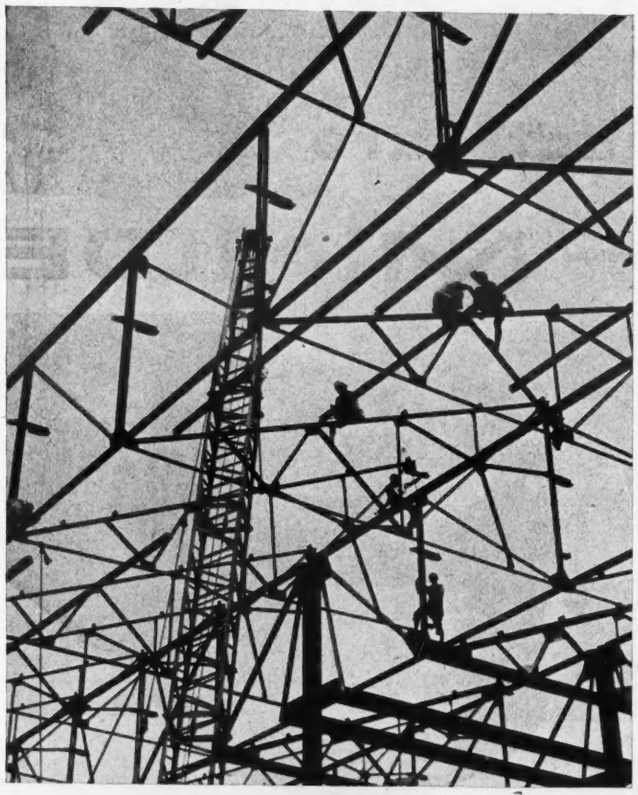

LOCATION—
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In course of erection is shown the lattice girders and roof trusses to the Light and Heavy Machine Shops and Loco Repair Shops for the Central Engineering Maintenance Department of the Durgapur Steel Project.
These form part of one of the several buildings of which the steelwork has been designed, fabricated and erected by CLEVELAND.

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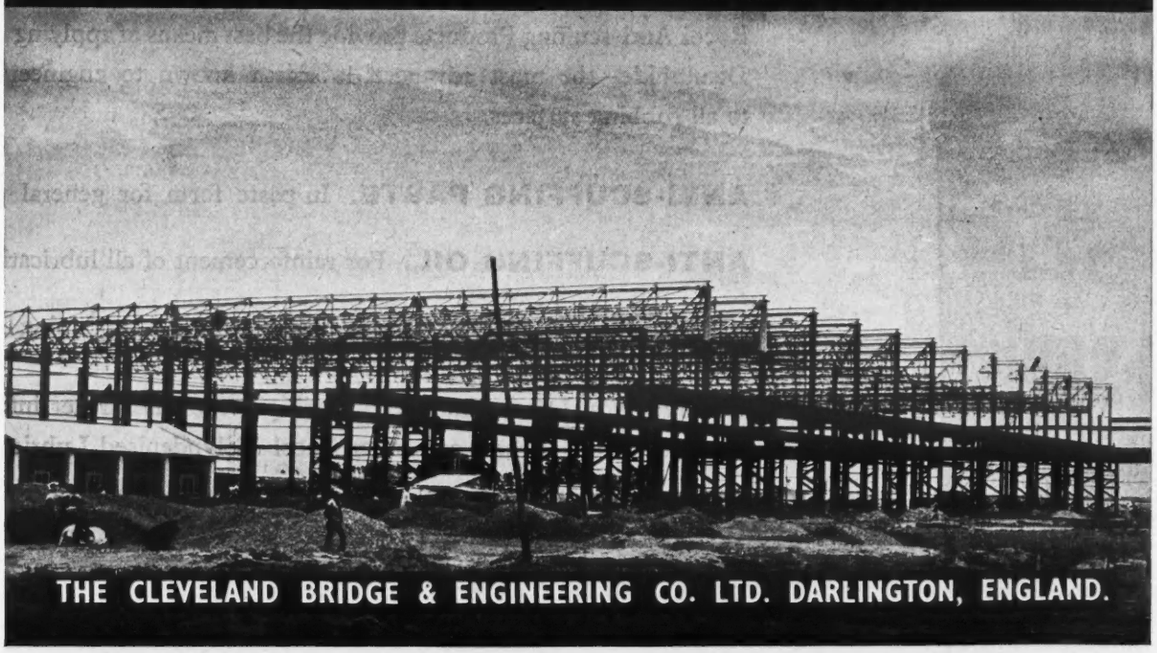

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General view of apex bolted connection

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The portal frame structure is fabricated from Universal beams; each arch was dispatched in four parts, later connected by high-strength bolts.

A feature of the steelwork was the provision for overhead lifting equipment for which the runways were suspended from the arches by A-frames; these are visible in the upper illustration.

Engineers & Contractors:
Industrial Development and Construction Ltd.,
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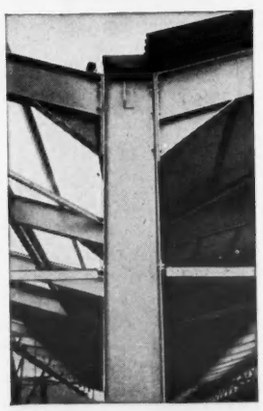

Detail of valley connection

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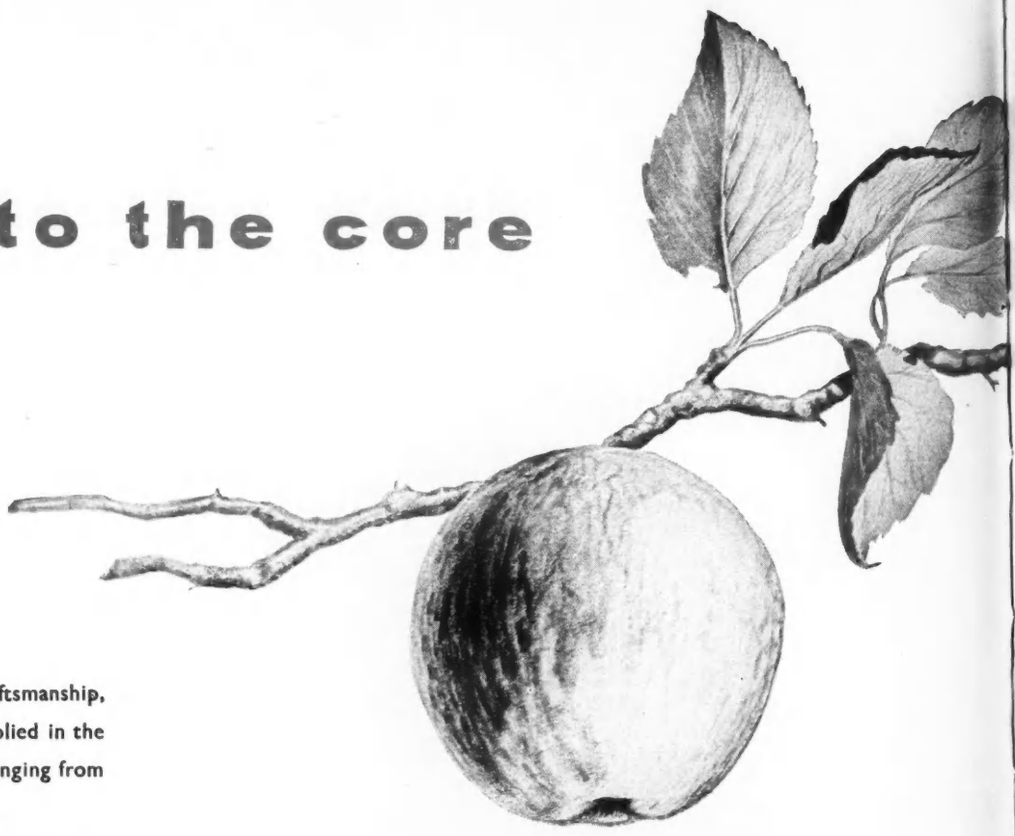

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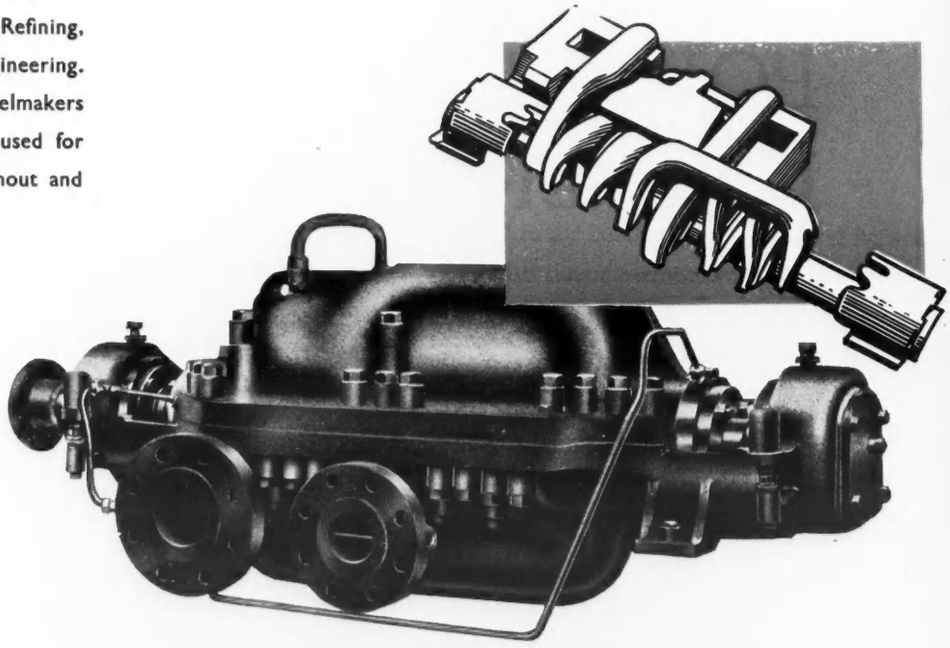

Osborn castings are used in this *Hayward Tyler - Byron Jackson six stage 'Multiplex' pump.* Inset illustrates core used for casting the upper half of casing.

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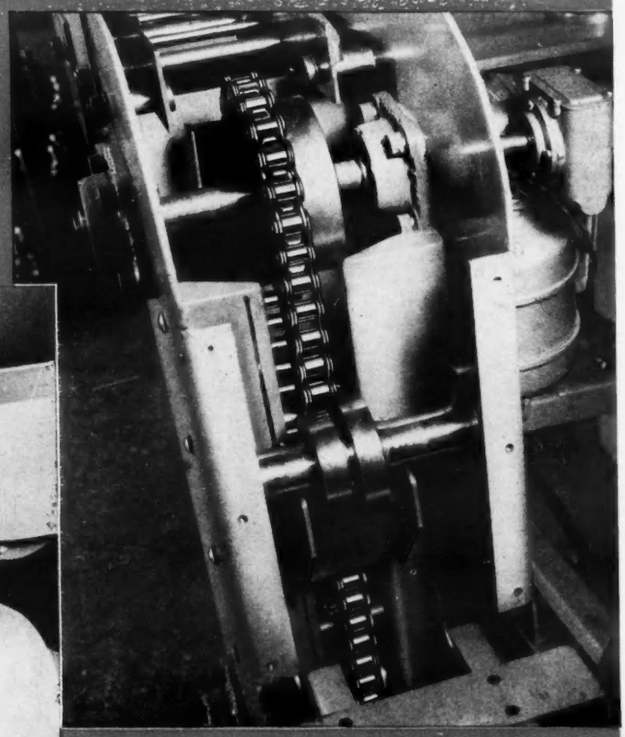

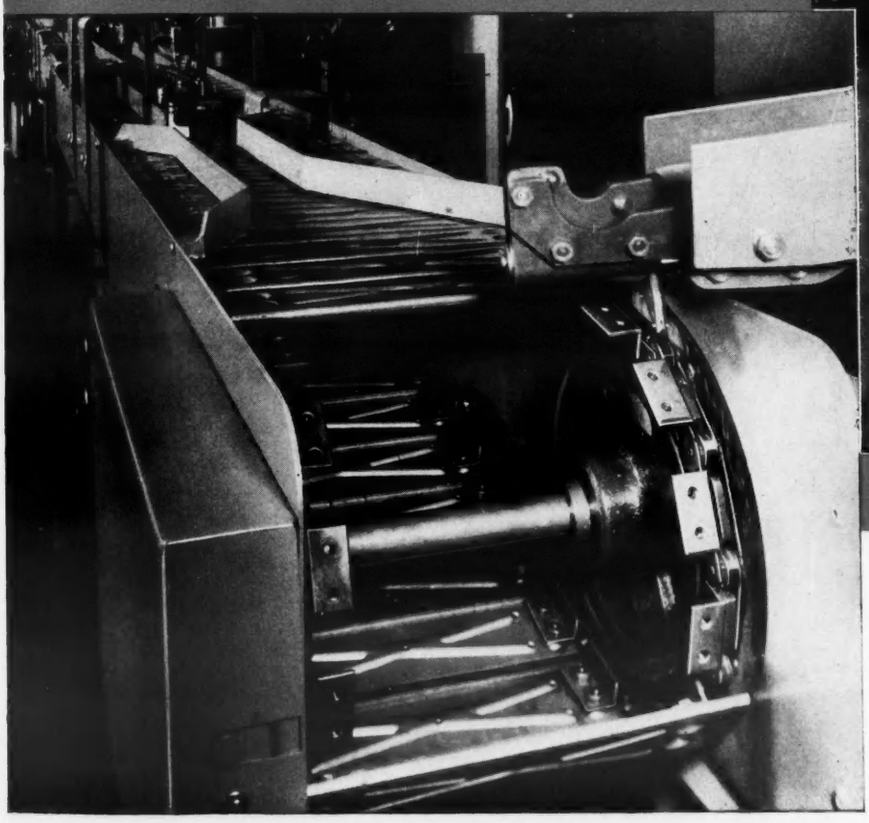

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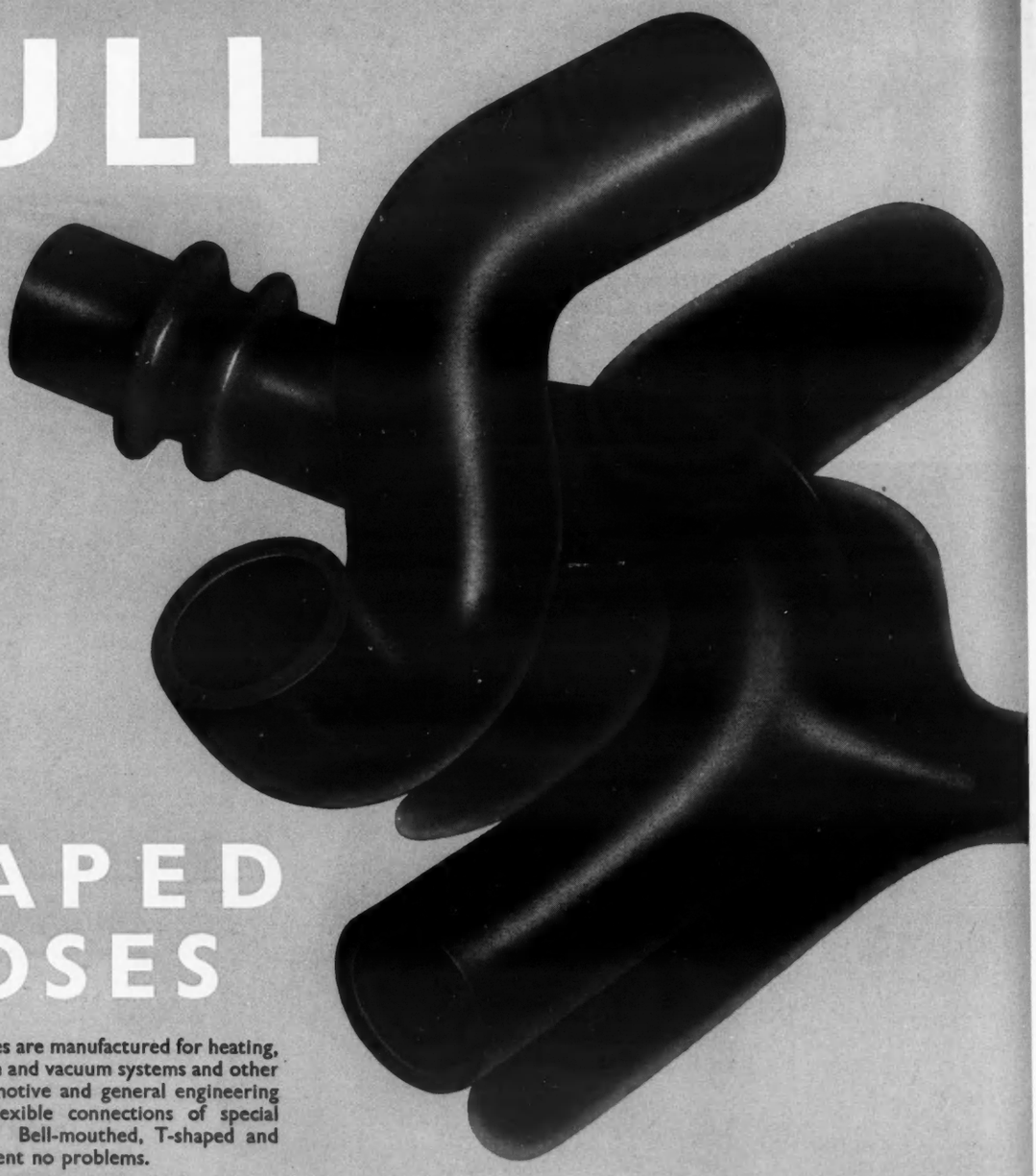

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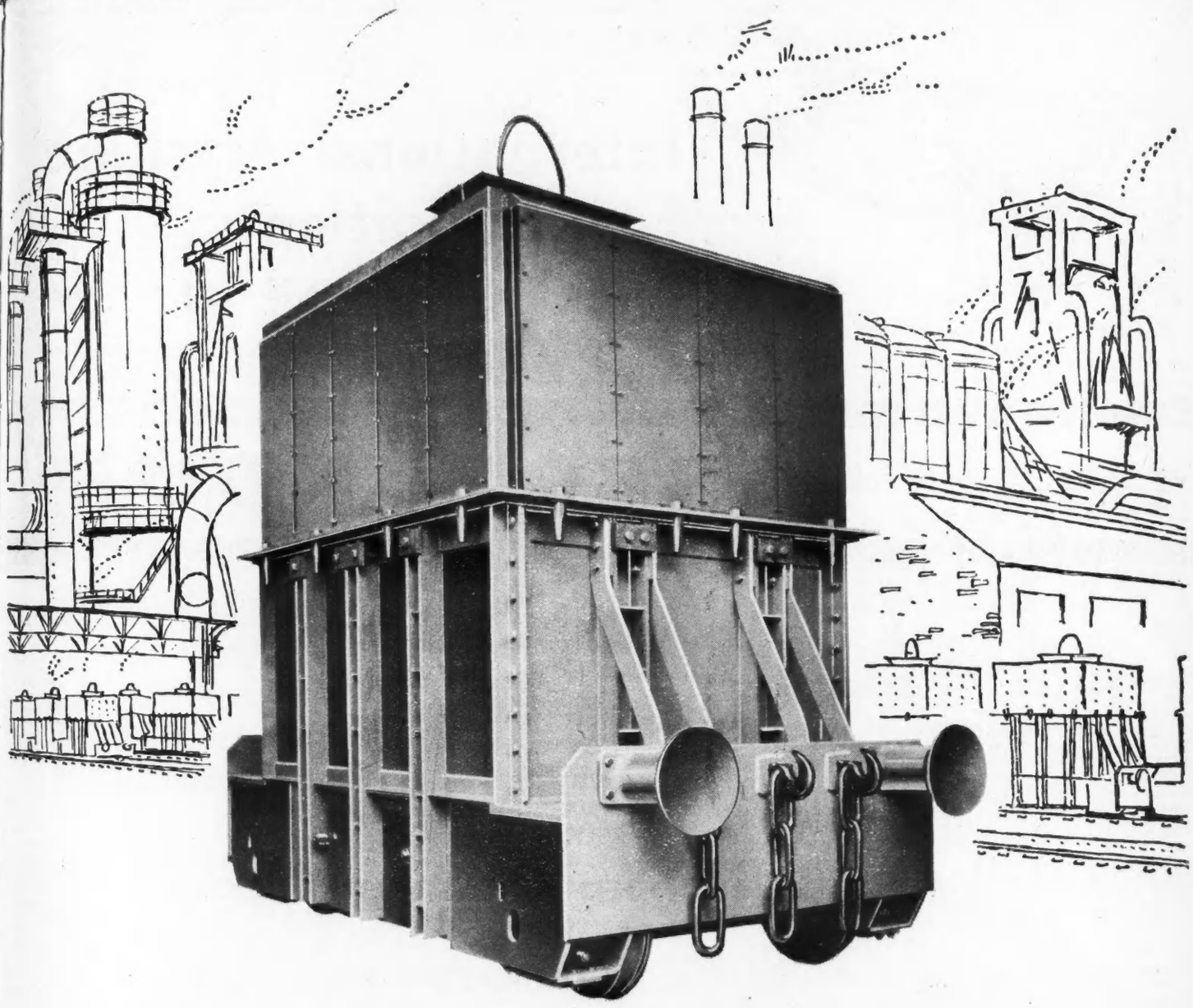

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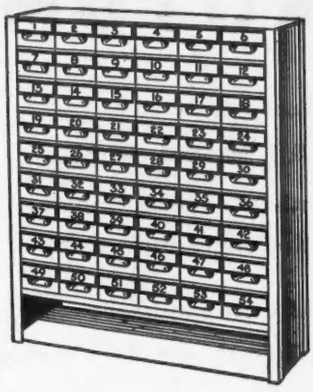

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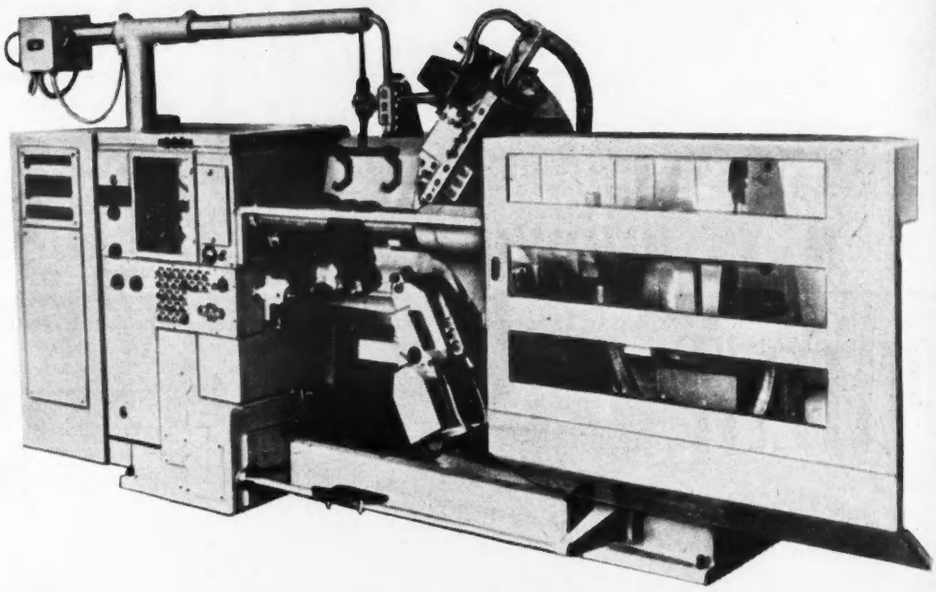

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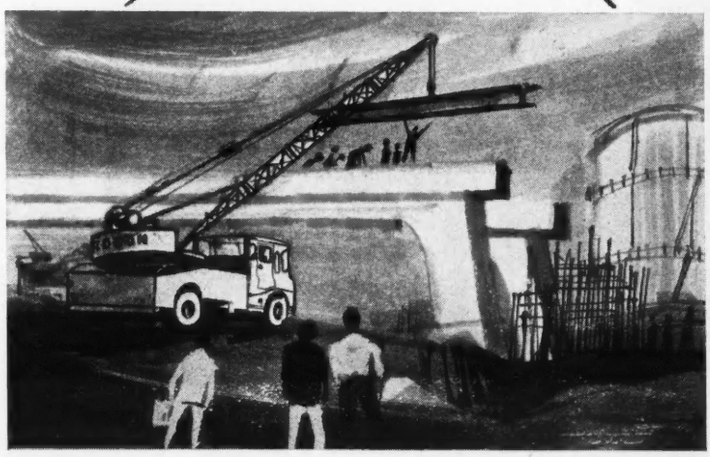

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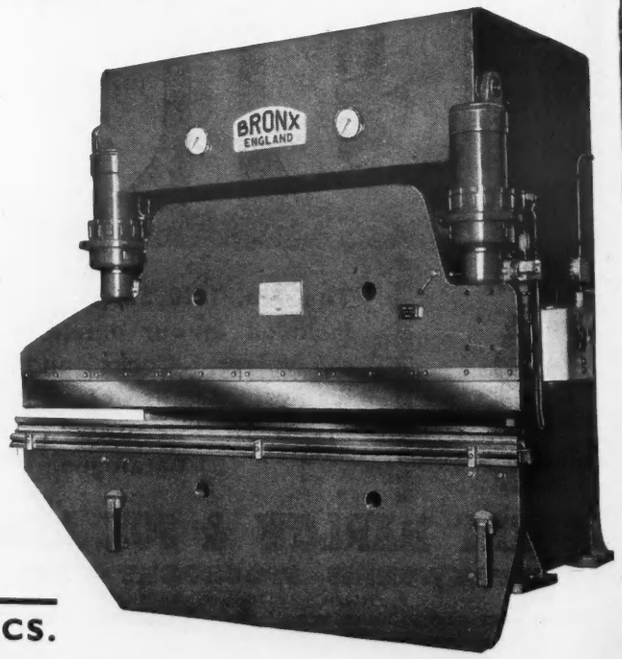

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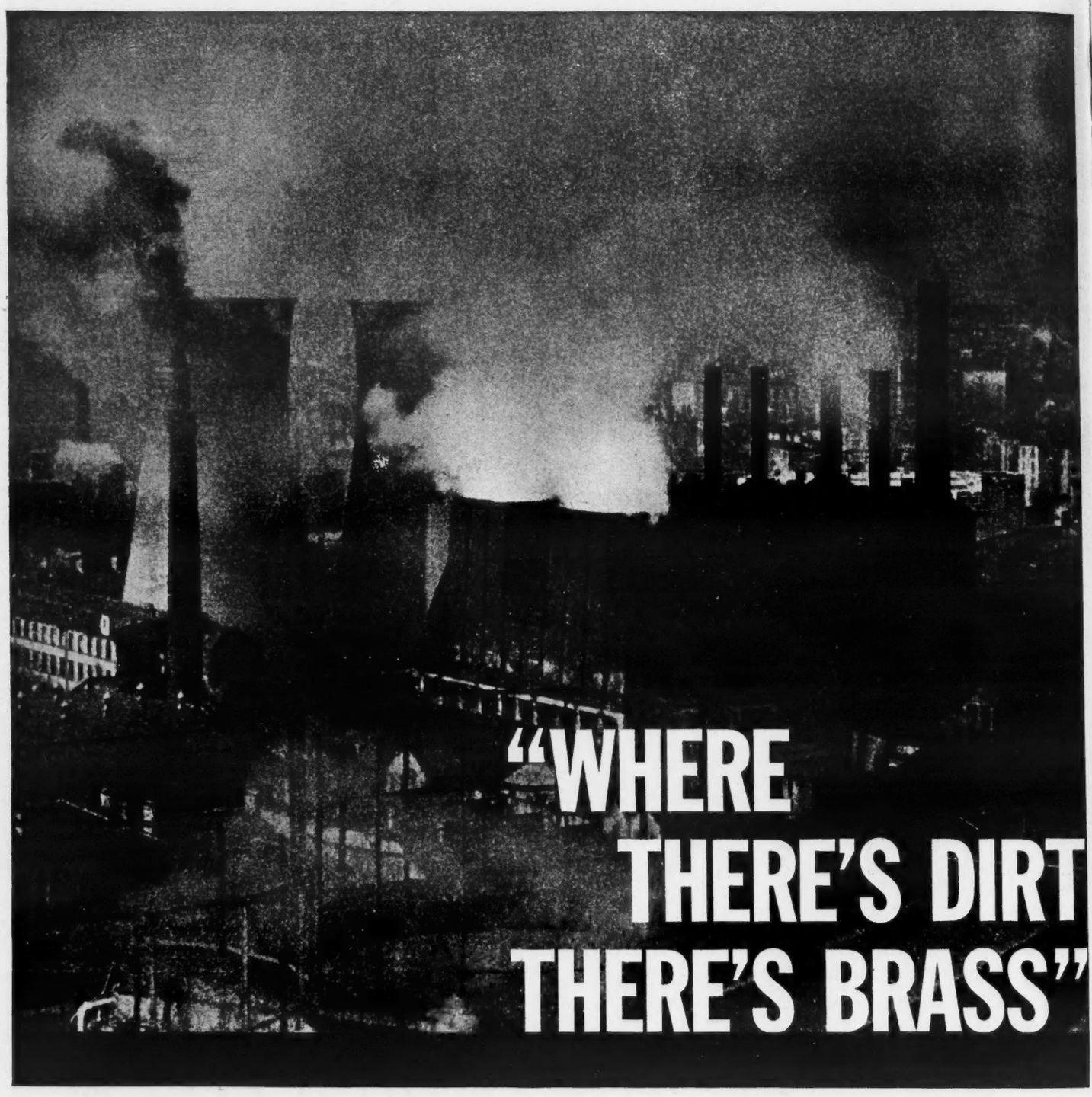

Where there's dirt there's brass was an accepted truth among our grandfathers, but today it is recognised that dirt in any form is the result of inefficiency.

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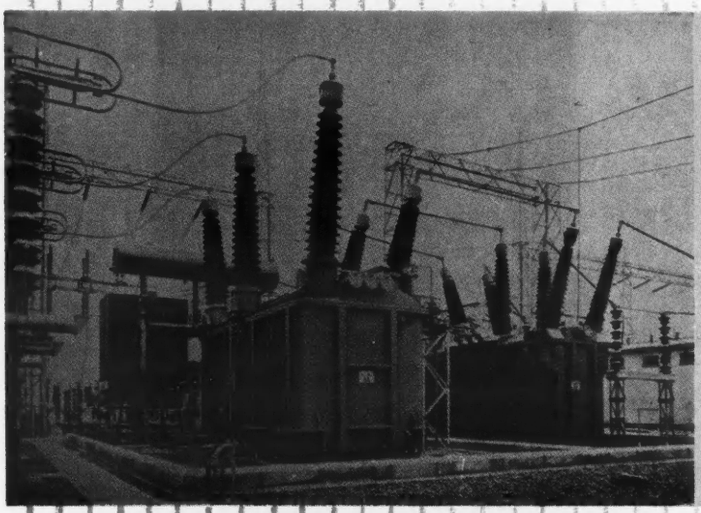
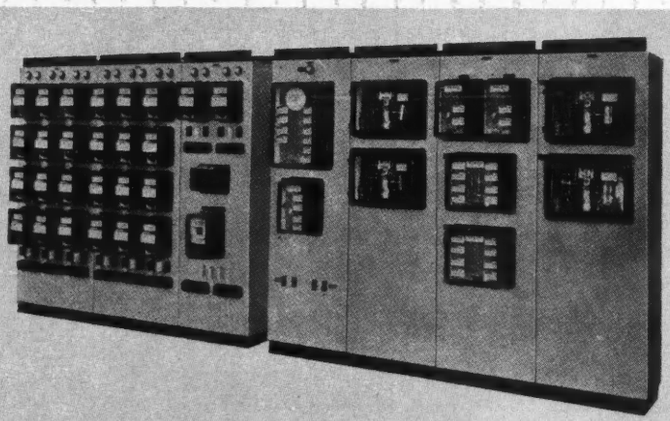


One of the two Ferranti 120,000 kVA 330/234 kV auto transformer and series booster installations at the Kitwe sub-station.

FERRANTI at KARIBA

Ferranti Summation Metering Panels for the Kariba Power Station.



The transformers and summation metering panels are for these sites.

TRANSFORMERS

All the sub-station transformers for the Kariba Hydro-Electric Scheme are being supplied by Ferranti Ltd. They comprise two 120,000 kVA, 330/234 kV 3-phase auto transformers with series boosters, eight 60,000 kVA, 330/88kV and four 60,000 kVA, 330/33 kV 3-phase double wound transformers. The transformer installations at Norton, Lusaka and Kitwe are complete. Work at Salisbury, Bulawayo and Sherwood is well advanced.

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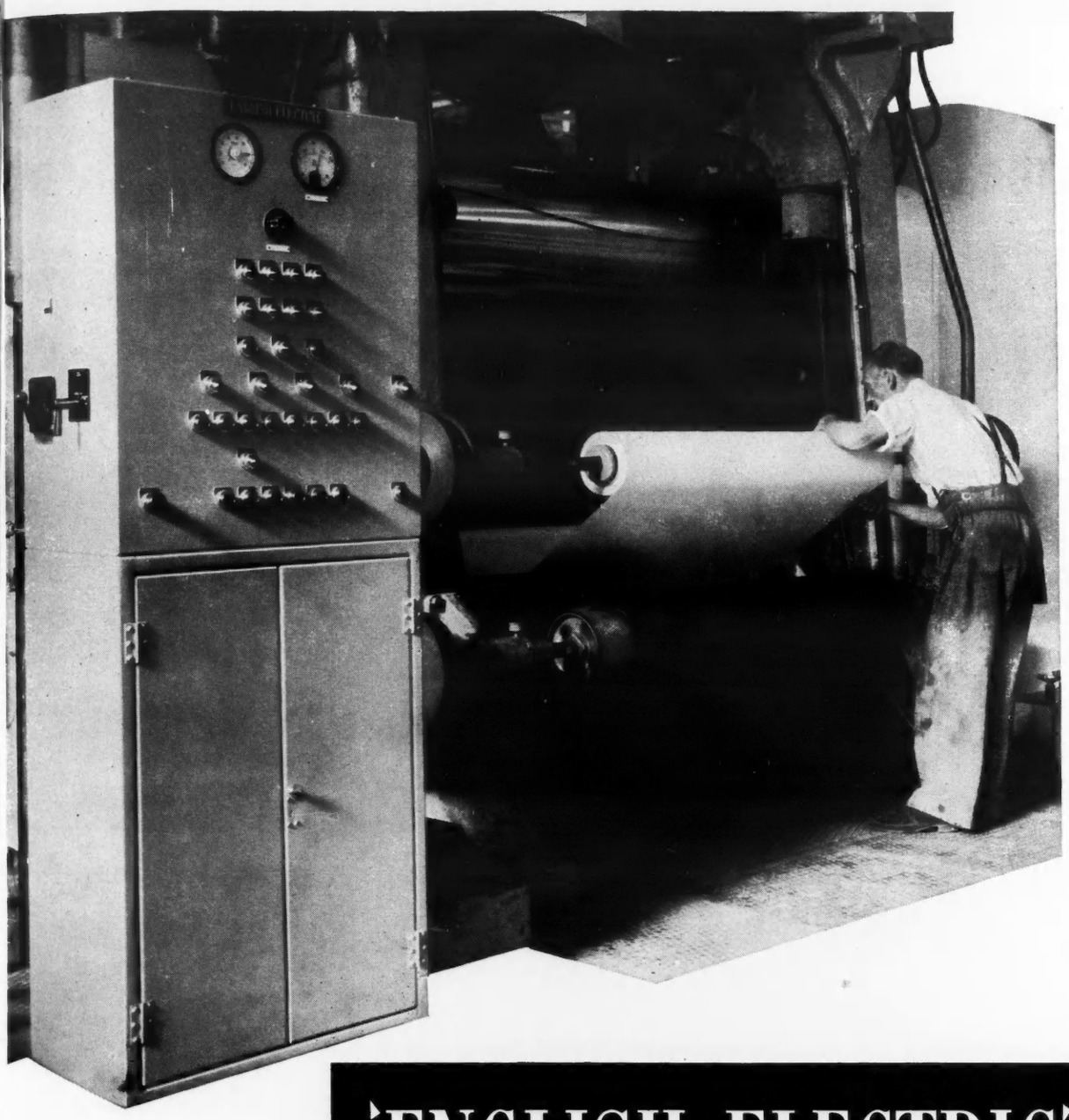

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drives for the rubber industry

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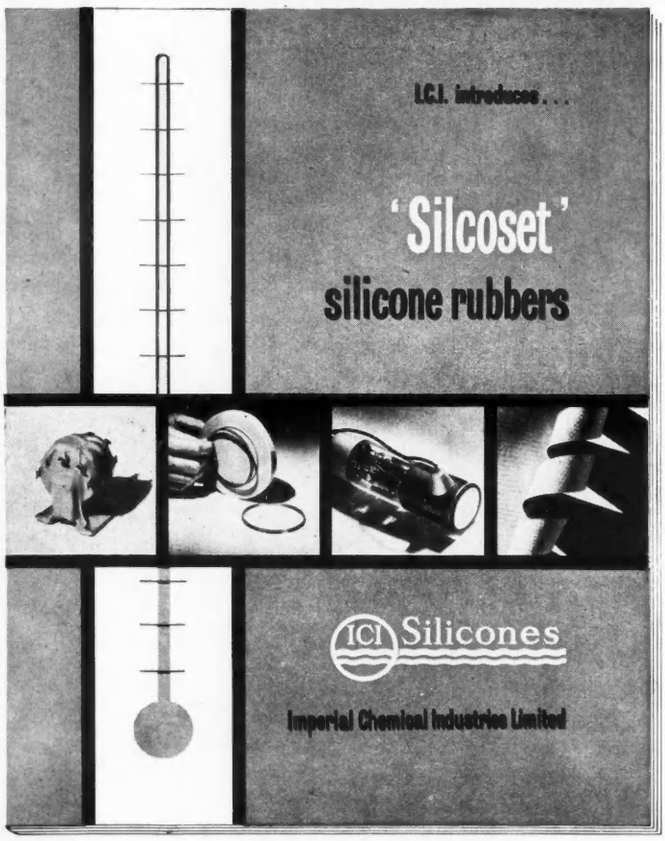

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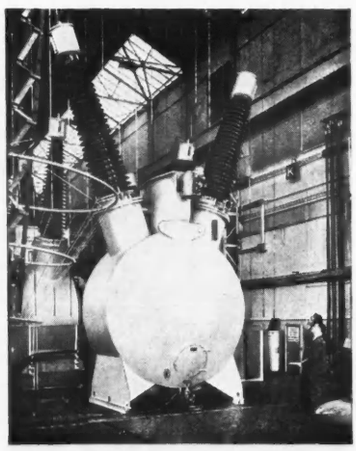

The illustrations show a complete 330 kV. bushing insulator and a 330 kV. circuit breaker, by courtesy of the B.T.H. Co.

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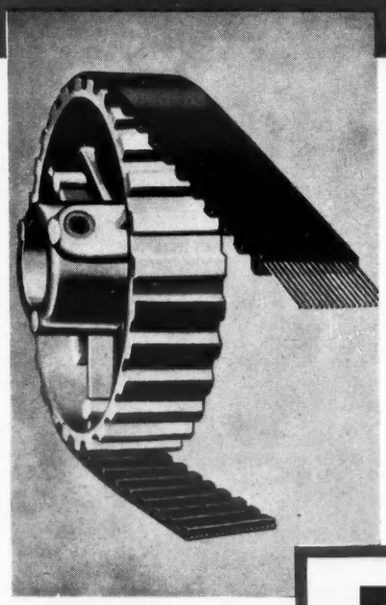

PowerGrip, the belt with teeth that grip to give near 100% mechanical efficiency.

PowerGrip, which has unusual flexibility and lightness, yet greater pulling power.

PowerGrip, for better performance and economy — without lubrication.

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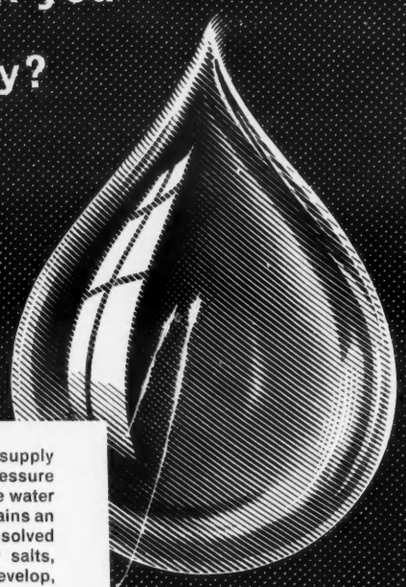
drop of water

could sink you financially?



A boiler is designed to supply pure steam at a given pressure and temperature. But if the water used for the purpose contains an excessive amount of undissolved solids, harmful gases or salts, serious trouble may develop, and everything be up with the boiler. The results—delayed production, extra costs and loss of profits could be disastrous.

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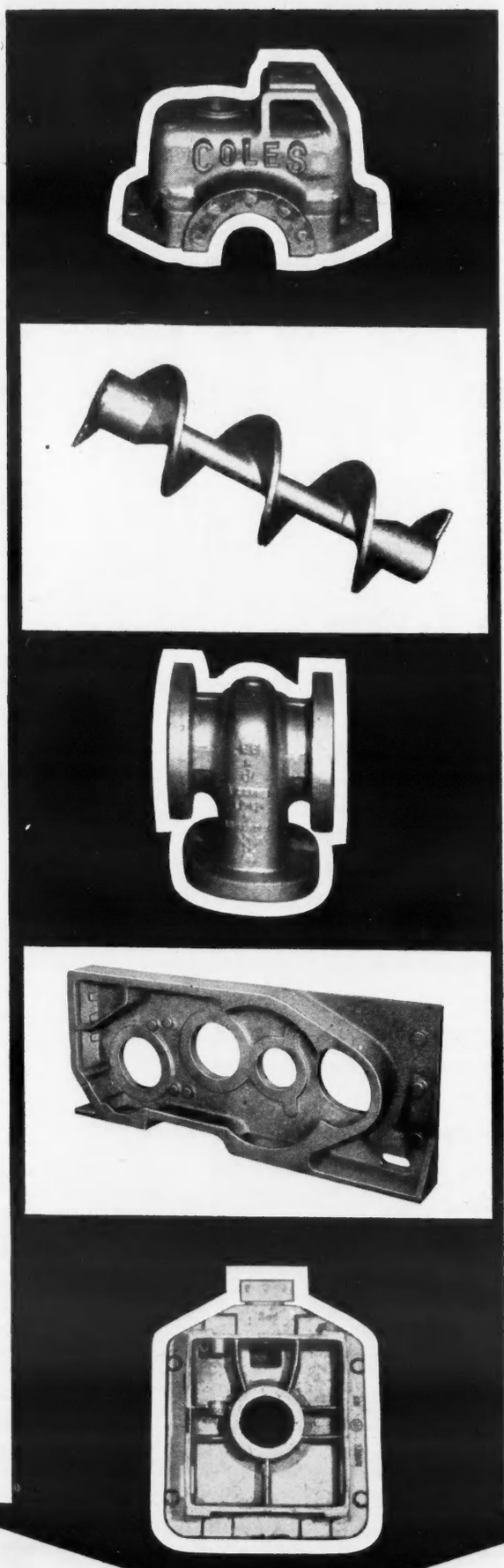

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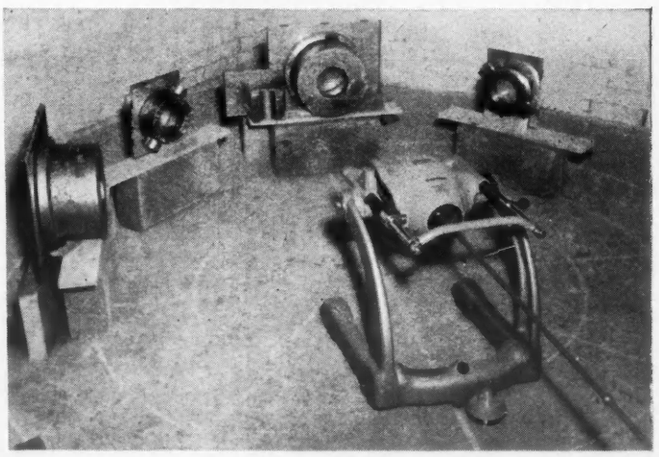

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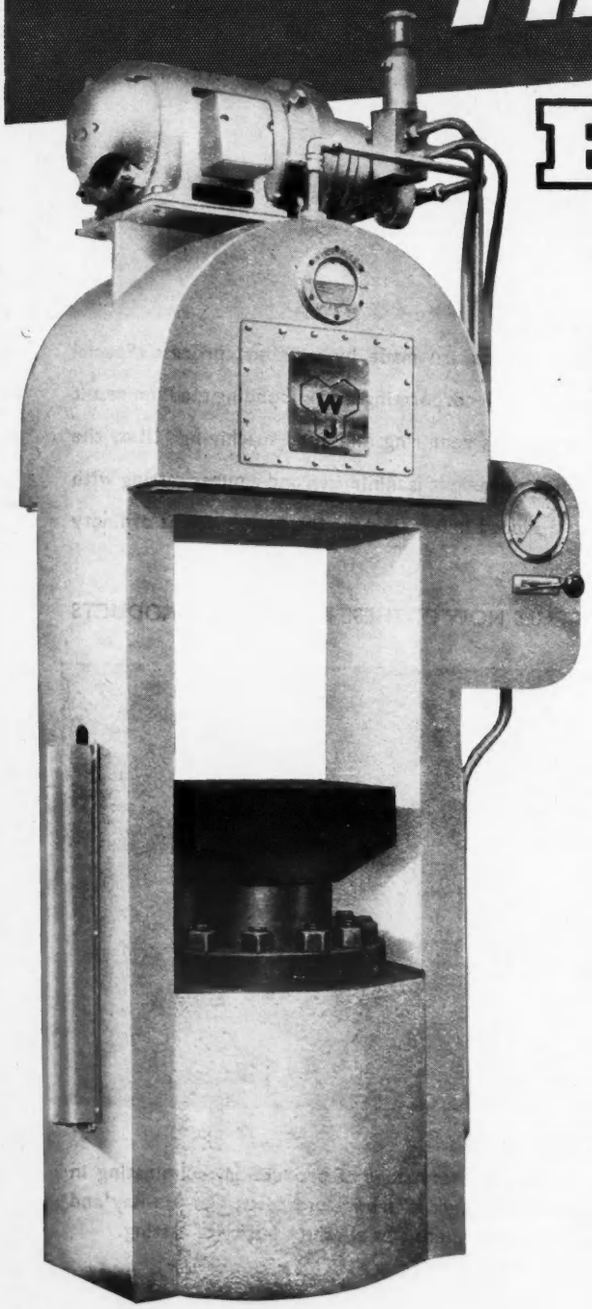

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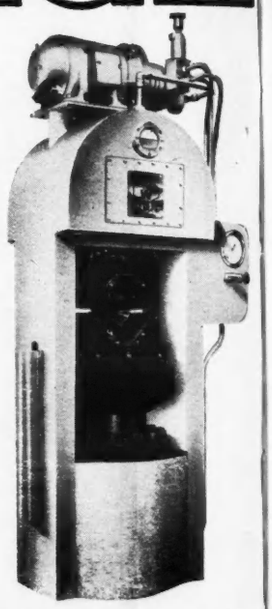

** A number of these Prestige Arch Presses are being supplied to British Ropes Ltd. for the SUPERLOOP mechanical splicing of wire rope.*

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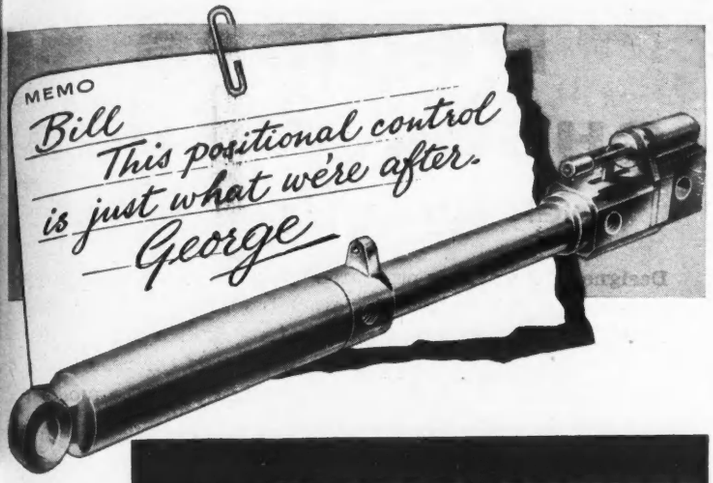

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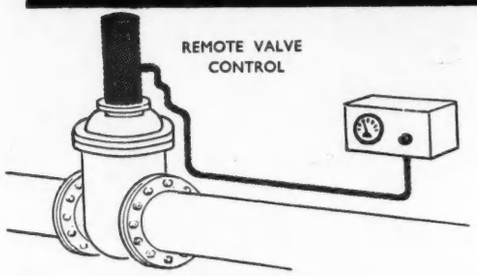

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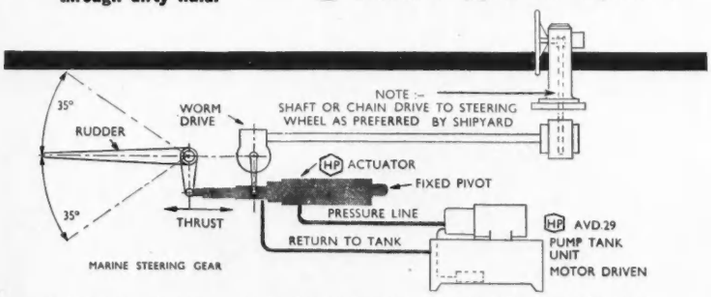

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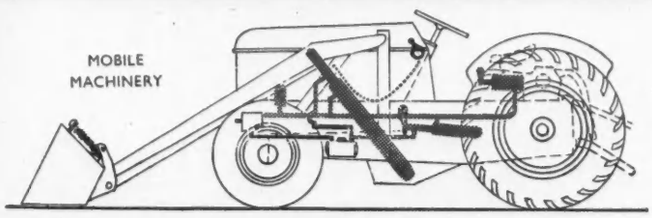

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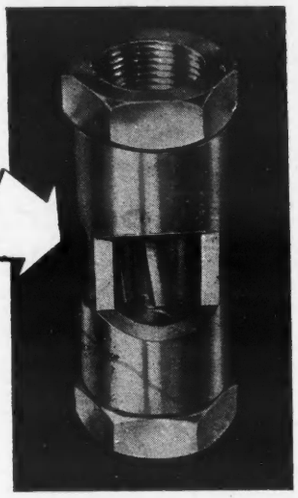

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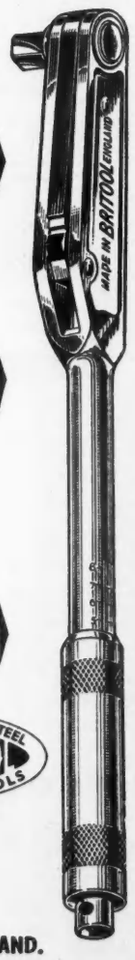

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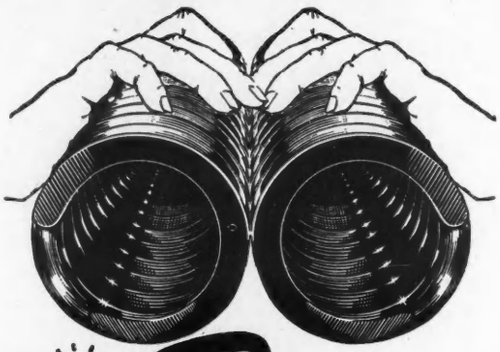

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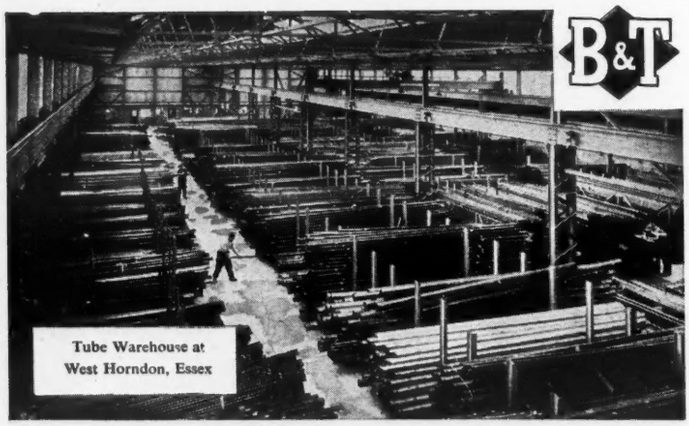

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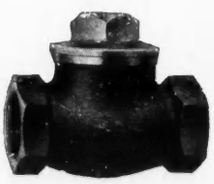

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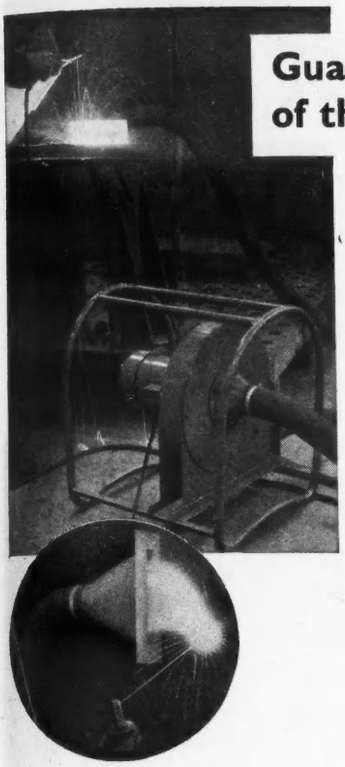

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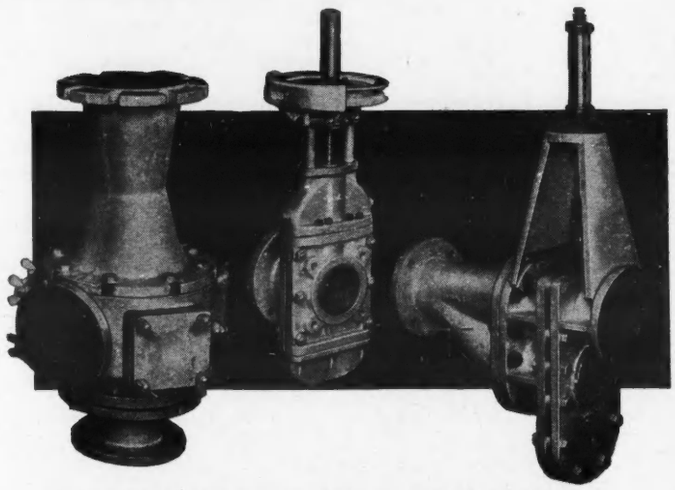

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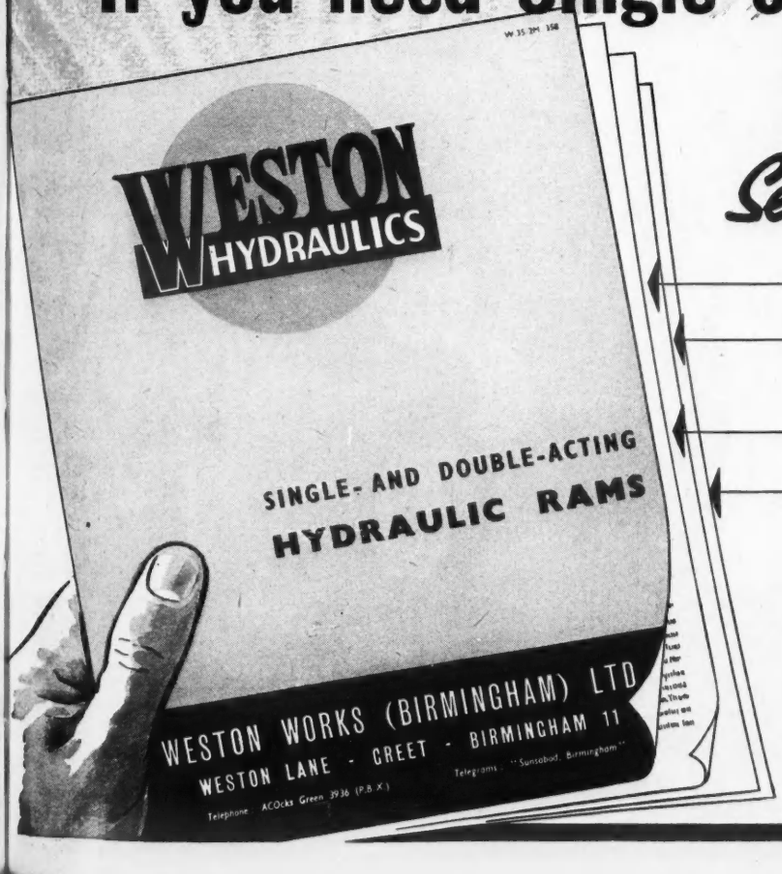

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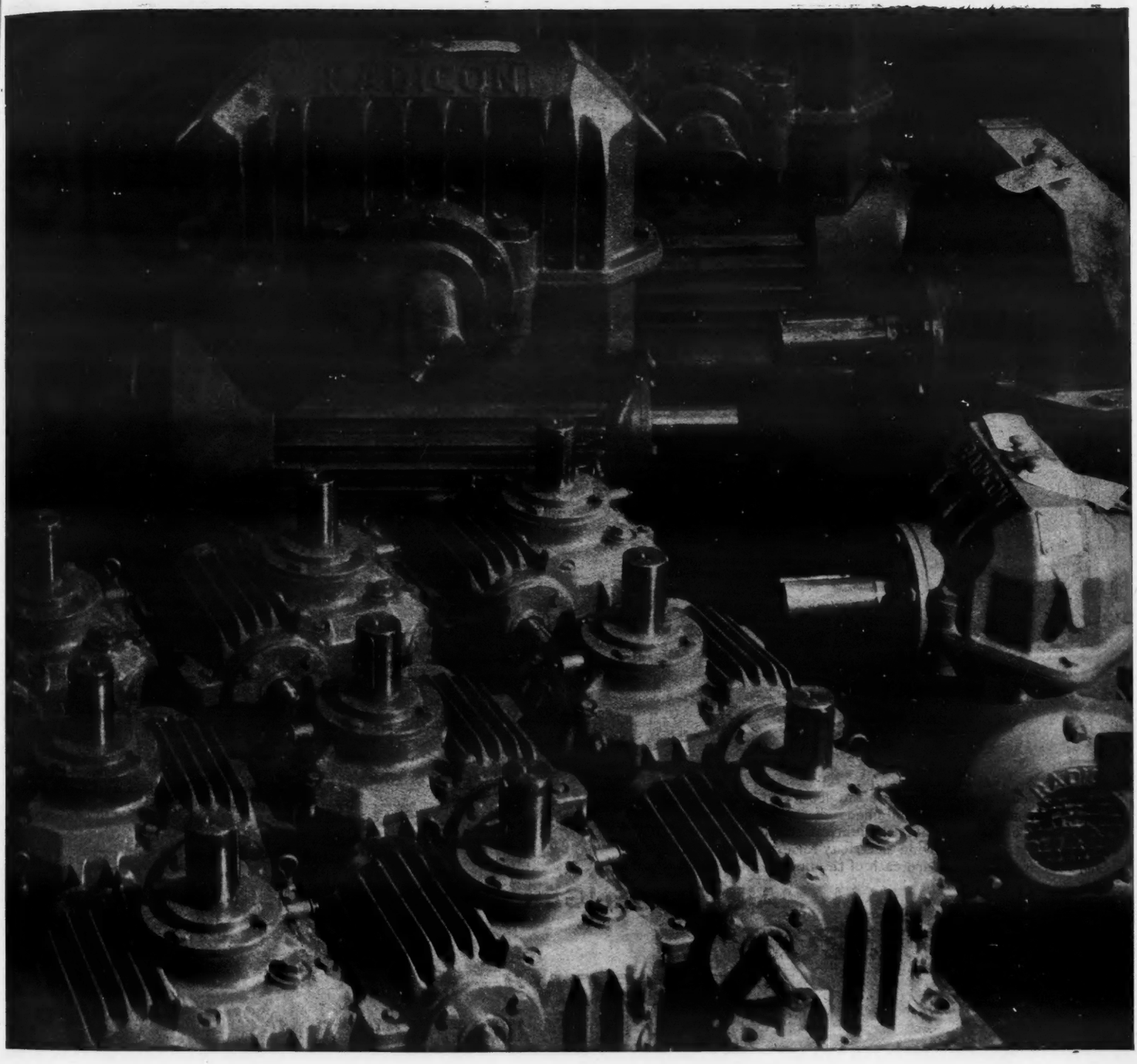

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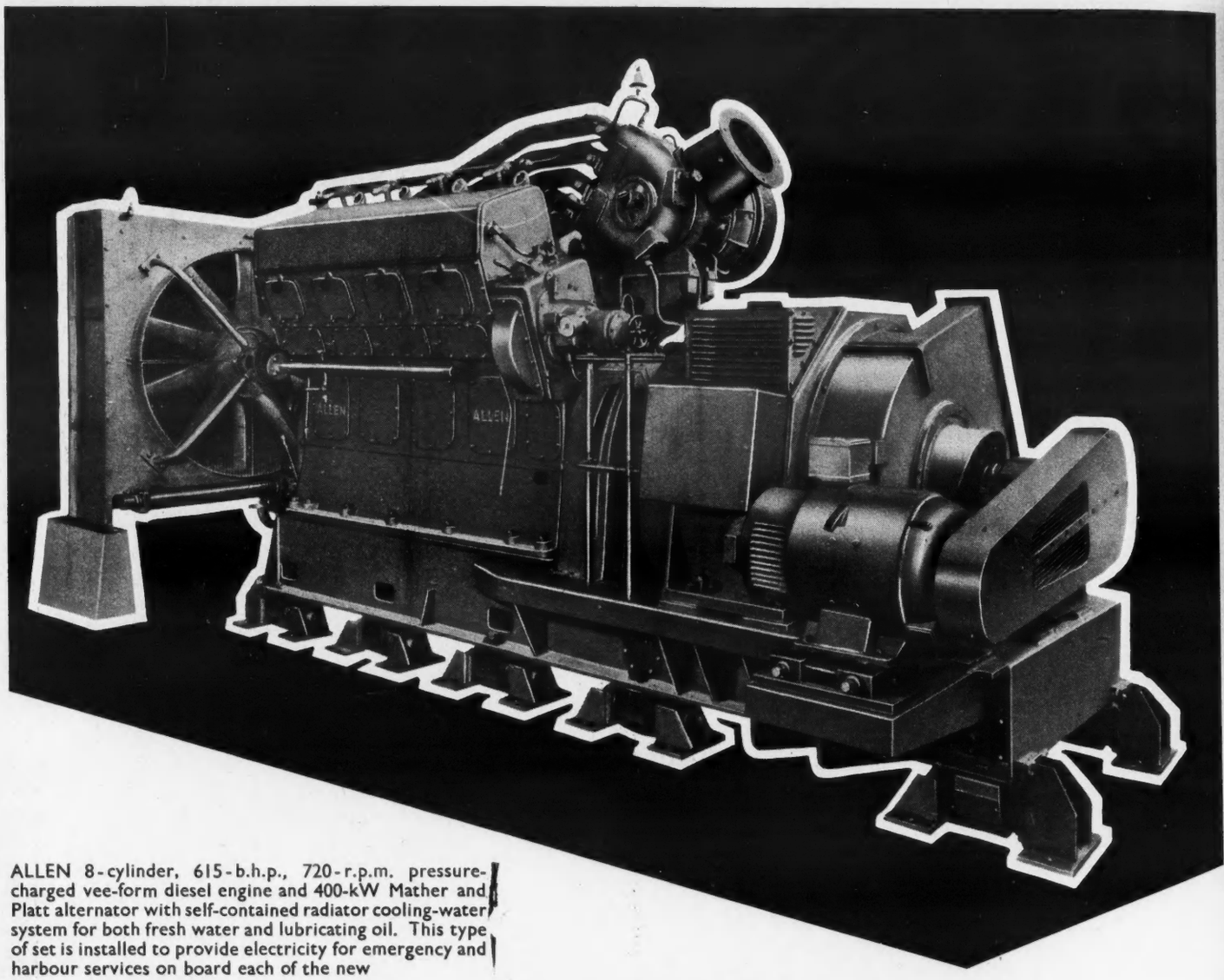

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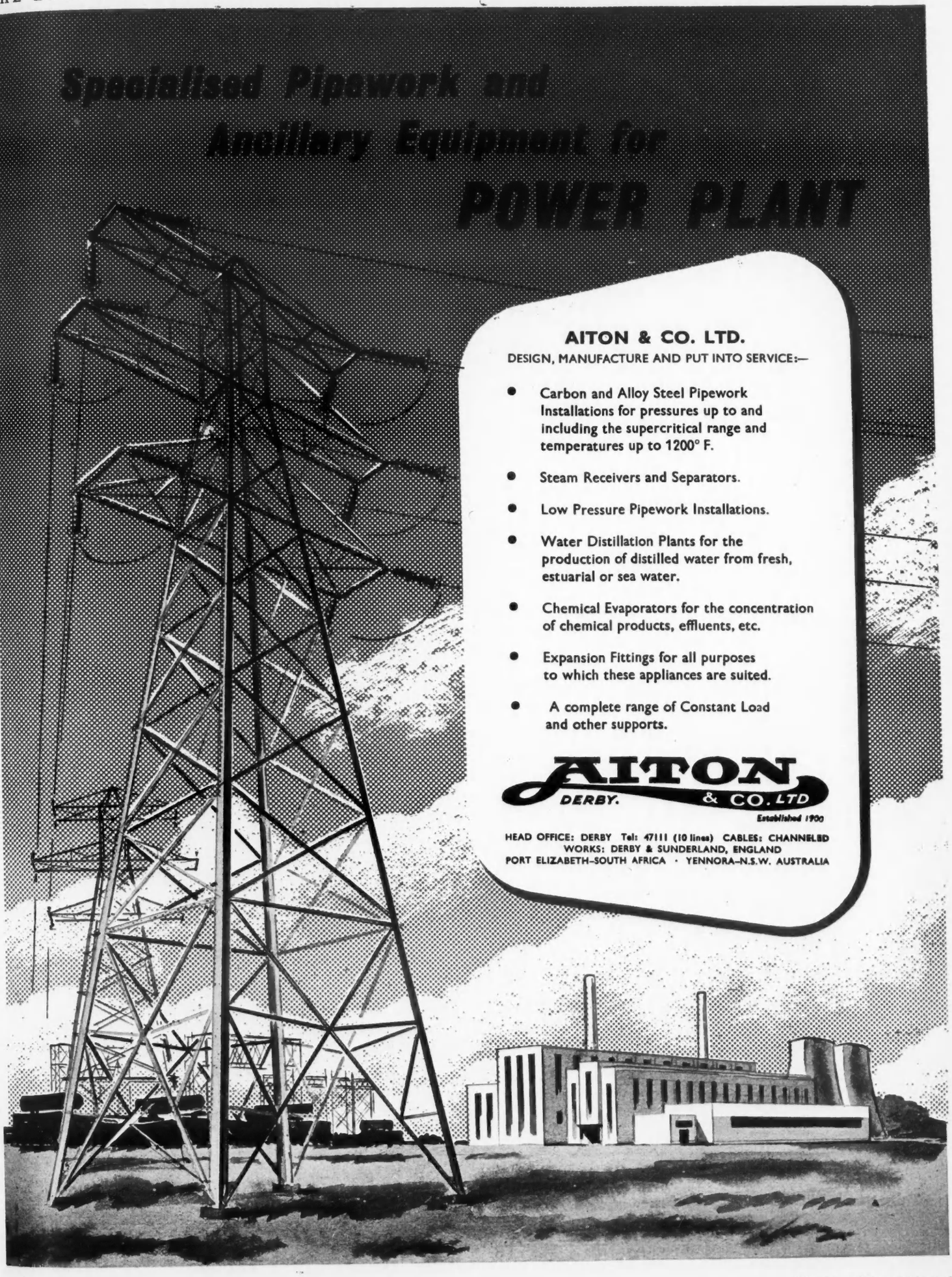

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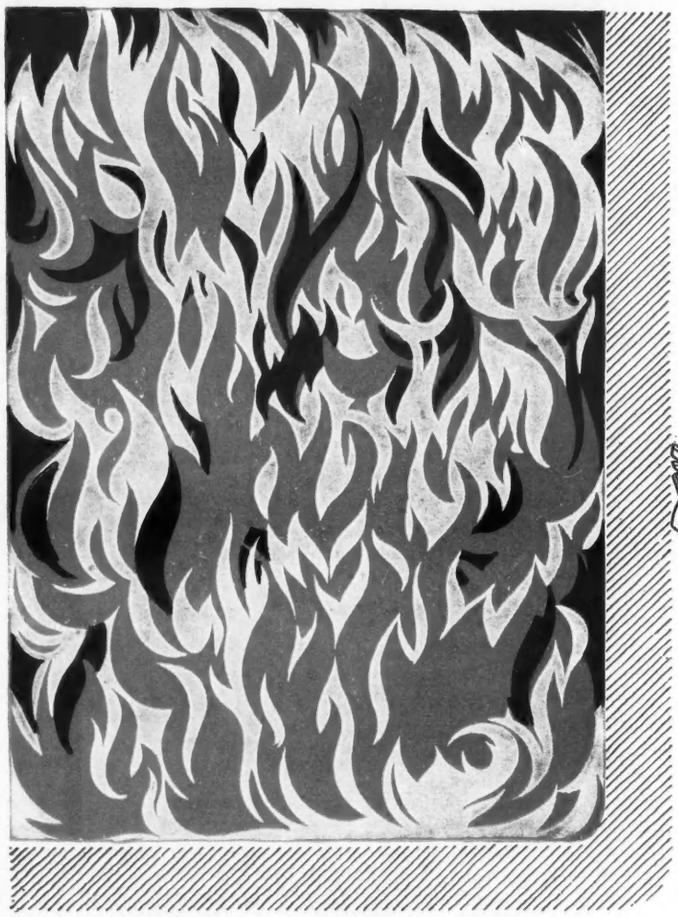

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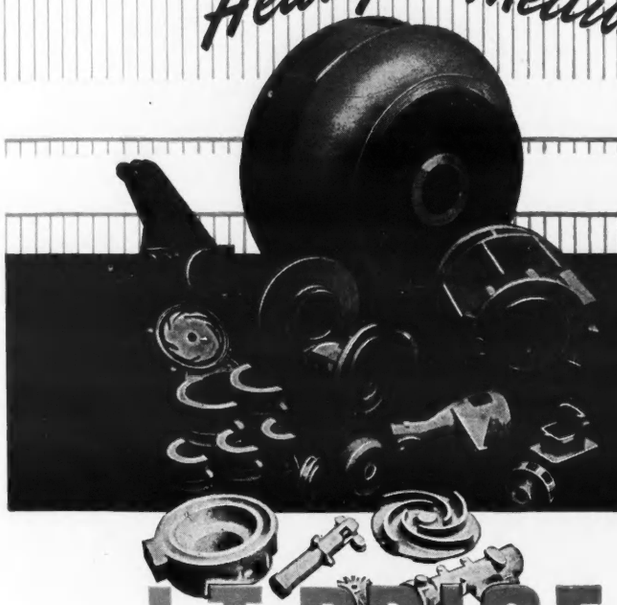

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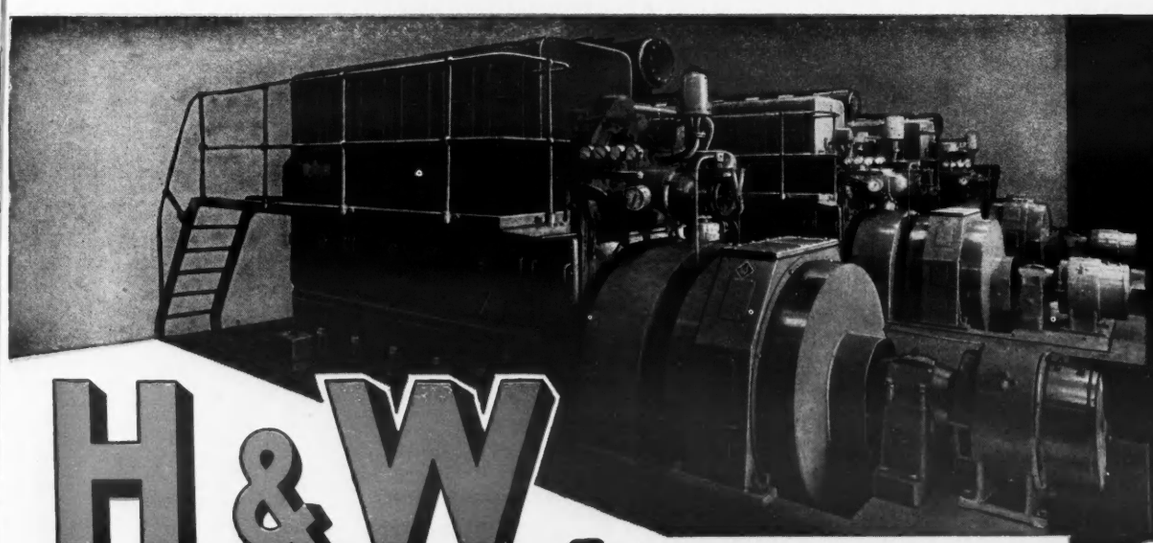

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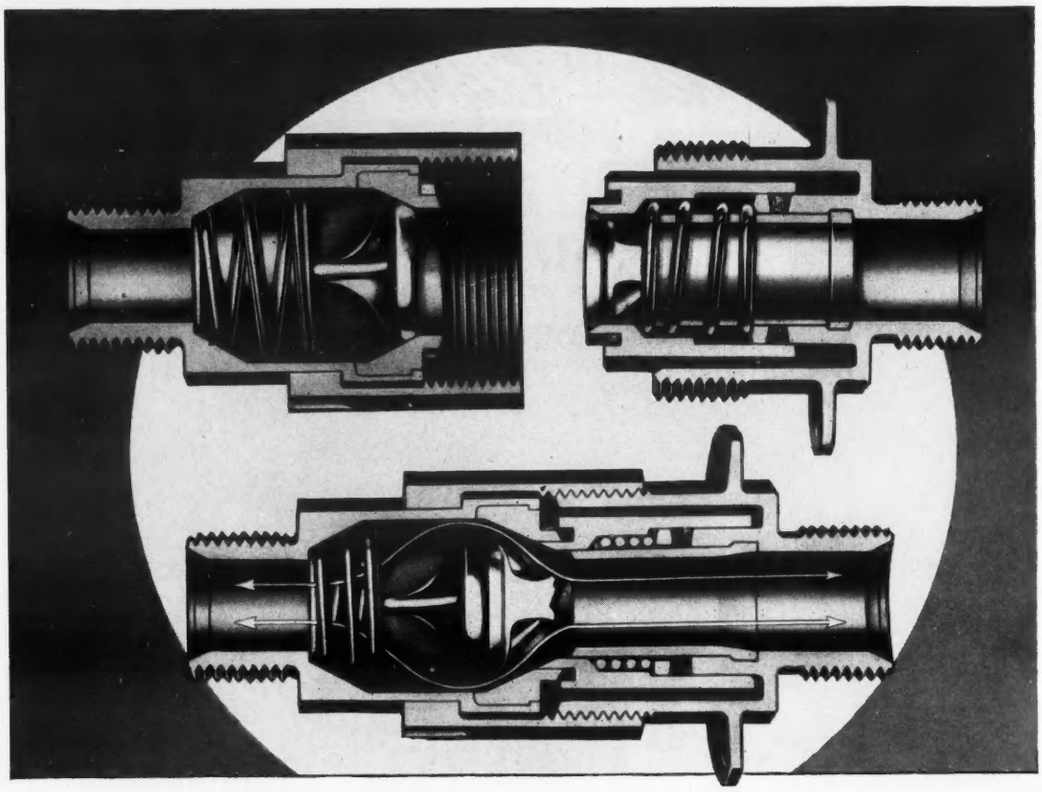

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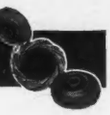

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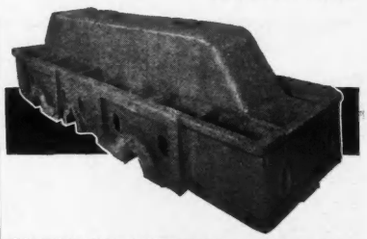

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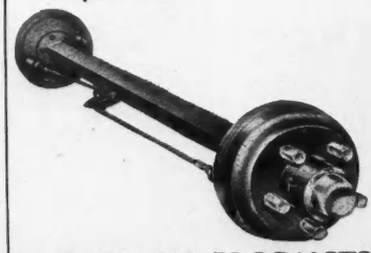

RUBBER BY PRODUCTS (Warwickshire) Ltd.
86 Holloway Head, Birmingham 1
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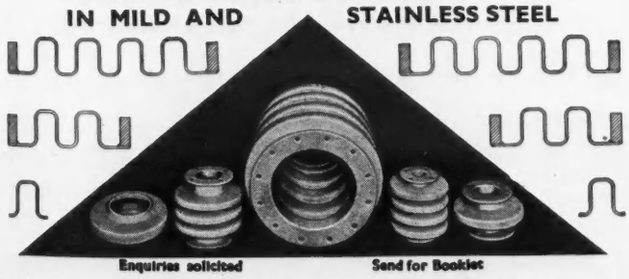
PRESSED STEEL BELLOWS TYPE IN MILD AND STAINLESS STEEL



Enquiries solicited Send for Booklet

also AIR RECEIVERS, CHIMNEYS, TANKS, PIPE WORK, PRESSURE CYLINDERS, AND FABRICATED STEEL PLATEWORK

BRITISH APPLIANCES MFG. CO., LTD.
DOLLY LANE, LEEDS, 9
Telephone 30725 Telegrams: STRUCTURAL LEEDS 9

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SPRINGS AND SPRING WASHERS
FOR ENGINEERING PURPOSES

Manufactured by
JOHN TONKS & CO LTD.
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Main Propelling Diesel Engines in powers up to **1,200 H.P.**

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INDUSTRIAL BELT & SCREEN CO., LTD.
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1760 SALTER 1960 BI-CENTENARY YEAR
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Congratulations to George Salter & Co. Ltd on the achievement of their Bi-Centenary

PHOSPHOR BRONZE AND COPPER WIRE, BAR, AND STRIP

for Springs manufactured by George Salter & Co. Ltd.

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THOMAS BOLTON & SONS LTD

Head Office:
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Established 1783

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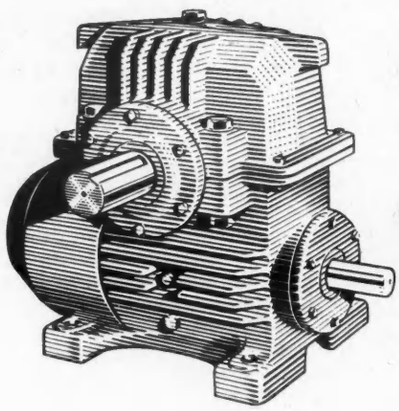
MOTOGEAR FOR SPEED REDUCTION



MOTOGEAR
SERIES **S**
FAN COOLED WORM REDUCTI
GEAR UNITS

These Units are manufactured in a range of 4 sizes and are capable of transmitting up to 30 HP dependent upon the input speed and ratio required.

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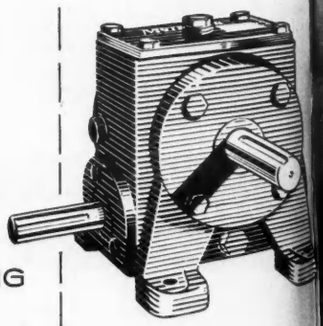
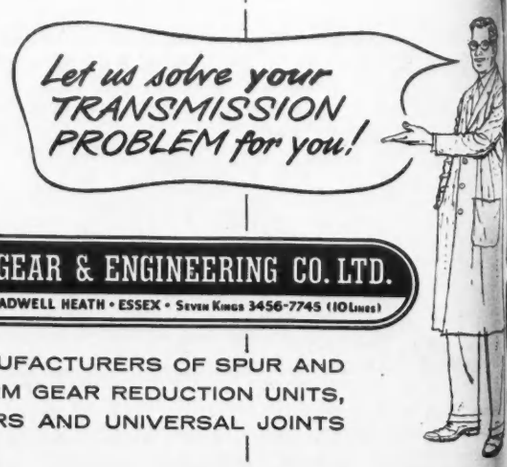
WORM REDUCTION GEAR UNITS
UNIVERSAL MOUNTING



Ideally suited for use with fractional HP motors and capable of being mounted in any desired position. They will transmit up to 2.1/2 HP depending on ratio and input speed.



THE MOTOR GEAR & ENGINEERING CO. LTD.
ESSEX WORKS • CHADWELL HEATH • ESSEX • Seven Kings 3456-7745 (10 Lines)

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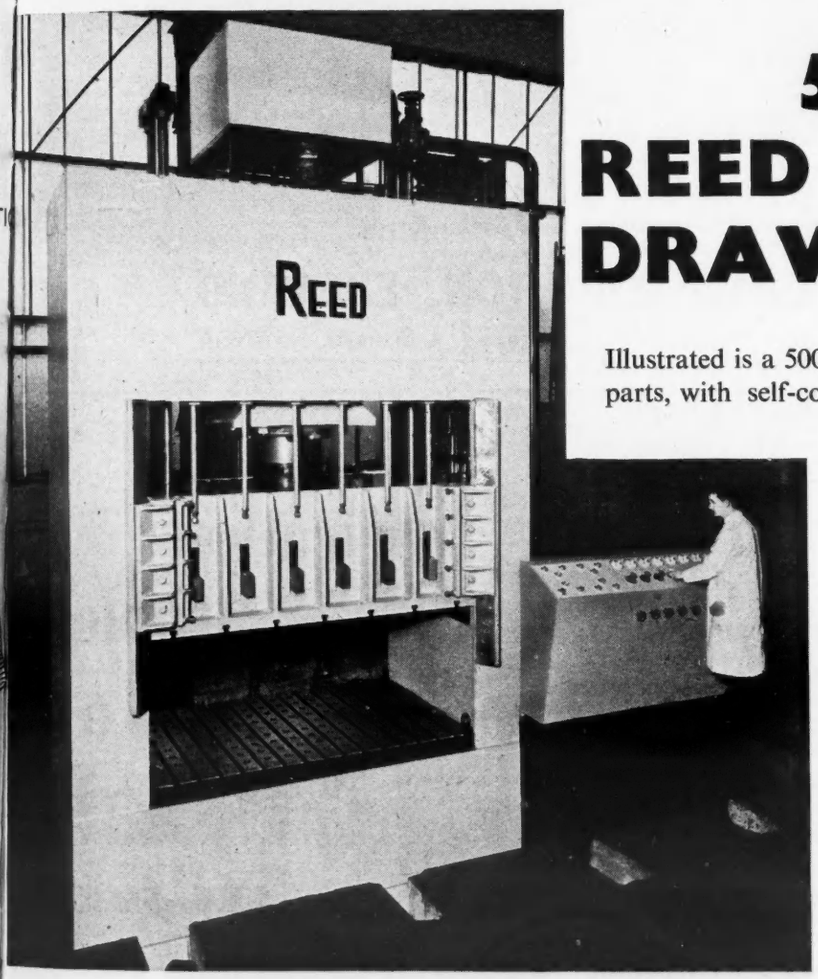
NEW HYDRAULIC DRAWING PRESSES by REED



500 TON REED HYDRAULIC DRAWING PRESS

Illustrated is a 500 ton Hydraulic Drawing Press for motor car body parts, with self-contained Pumping Unit and push-button control.

NEW POWER BY REED

Including Forging, Extruding, Sheet Metal Drawing, Scrap Metal Baling, Dishing and Flanging, Plastics and Rubber Hot Plate Presses.

Enquire from the Hydraulic Specialists
Demonstrations arranged

Sole Manufacturers and Selling Agents in the U.K. for REED LOMBARD 5-tube Drawbenches

Quotations supplied for "CUSTOM BUILT" Hydraulic Equipment to customers' specific requirements.

REED BROTHERS (ENGINEERING) LIMITED

REPLANT WORKS, WOOLWICH INDUSTRIAL ESTATE, LONDON SE18. Phone: WOOlwich 7611/6. Cables: Replant, London.

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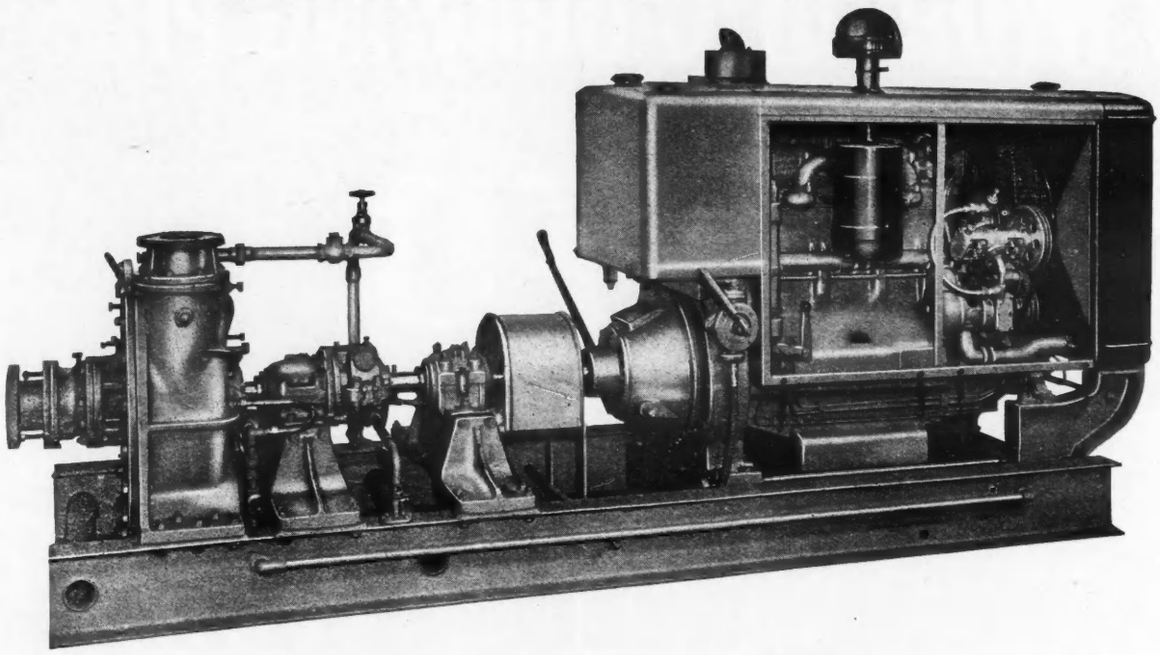
GRAVEL PUMPS



4½/5" Centrifugal Sand and Gravel Pump with Diesel Engine Drive.

EASTON & JOHNSON LTD. · TAUNTON, ENGLAND

TELEPHONE 3146 GRAMS: EASTWALD, TAUNTON

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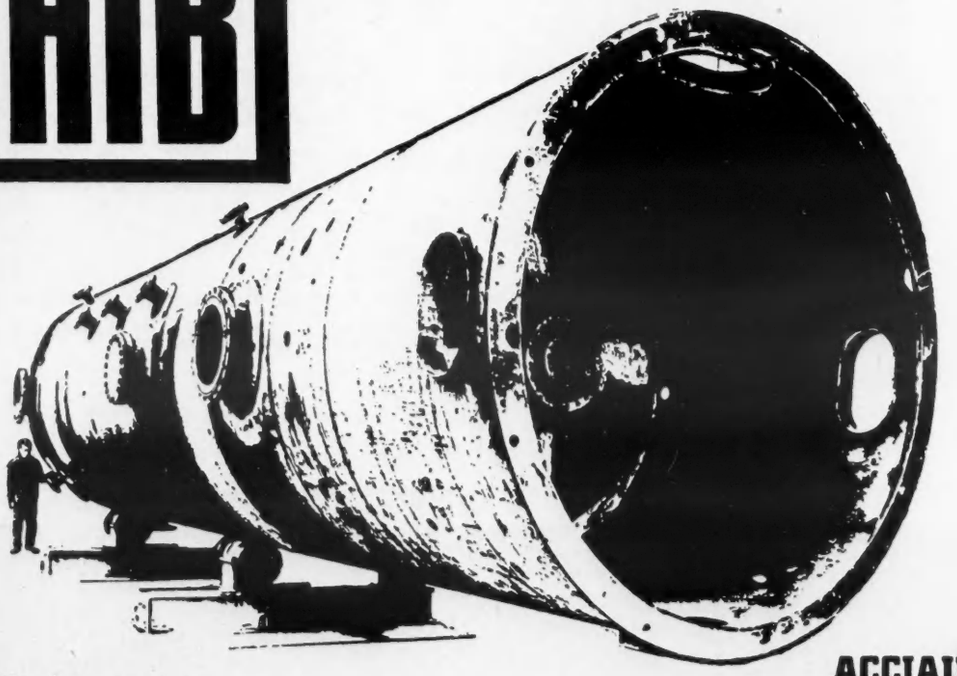

One large reactor
for synthetic rubber industry
Weight when empty 85 m. Tons.

PRESSURE VESSELS

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A.T.B. FACILITIES

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HEAT TREATMENT, RADIOGRAPHY
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DIE-PRESSED 2 : 1 ELLIPTICAL
HEADS UP TO 13" DIAMETER
& 5" THICKNESS

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CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. **Minimum** 18/–. **Inch Rate.** 54/– per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

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There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/– which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

Advertisements for publication should be addressed to :—**Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London. W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

LONDON COUNTY COUNCIL

SOUTH EAST LONDON TECHNICAL COLLEGE

LECTURER

LECTURER in ELECTRICAL ENGINEERING required as soon as possible. Salary within scale £1408 by £35 to £1601, according to age and experience.

ASSISTANT LECTURER, GRADE "B" required. Burnham (F.E.) salary scale £700 by £27 10s. to £1150, plus London allowance and additions for training and qualifications. Increments within scale for experience. (i) To teach general subjects in O.N.C. Mechanical Engineering course ; should be graduate of a British University and/or Corporate Member of the Institution of Mechanical Engineers. Good engineering, industrial experience and some teaching experience essential. Required in September. (ii) To teach Production Techniques, Workshop Practice and Technology in the Final City and Guilds Instrument-making Course S.3, Mechanics and Drawing.

Application forms from the Secretary at the College (FE3a/E/1567/6), Lewisham Way, S.E.4, returnable within two weeks of advertised date.

E5150

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY

ST. JOHN STREET, LONDON, E.C.1

APPOINTMENTS

Northampton College of Advanced Technology, St. John Street, London, E.C.1, requires :

(1) LECTURERS and SENIOR LECTURERS with honours degrees and industrial or research experience for the following subjects :

MECHANICS OF FLUIDS
MECHANICS OF MACHINES
APPLIED THERMODYNAMICS
STRENGTH OF MATERIALS

(2) ASSISTANT LECTURER in ENGINEERING DRAWING, preferably with degree or equivalent, and industrial experience.

These vacancies arise from the continued expansion of the College in Degree, Diploma in Technology, and post-graduate studies.

Salary scales : Senior Lecturer, £1588 rising to £1801. Lecturer, £1408 rising to £1601. Assistant Lecturer, initially in range £828 to £1263, rising to £1291 to £1396.

Particulars and forms of application are obtainable from the Secretary. E5143

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY

ST. JOHN STREET, LONDON, E.C.1

GRADUATE RESEARCH ASSISTANTS

GRADUATE RESEARCH ASSISTANTS are required by Northampton College of Advanced Technology, St. John Street, London, E.C.1, for projects in Applied Photoelasticity, Fatigue of Metals and Impact Testing. Those appointed will be expected to work for a Higher Degree of London University. Salary about £500 p.a., including payment for some assistance in laboratory and tutorial classes. Candidates graduating this year will be considered.

Further particulars and application forms are obtainable from the Secretary. E5144

UNIVERSITY OF MANCHESTER

LECTURER IN ENGINEERING (CIVIL)

Applications are invited for up to four posts of LECTURER IN ENGINEERING (CIVIL). It is desired to make appointments from applicants particularly interested in any of the fields of Hydraulics Soil Mechanics, Structural Concrete, Metal Structures and Surveying. The salary scale is £1050 to £1850, with initial salary according to qualifications and experience. Membership of F.S.S.U. and Children's Allowance Scheme. Applications should be sent not later than June 25th, 1960, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of applications may be obtained. Applications by airmail letter in the first instance will be considered from overseas candidates.

E5043

PUBLIC APPOINTMENTS

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

TWICKENHAM TECHNICAL COLLEGE

EGERTON ROAD, TWICKENHAM, MIDDLESEX

ASSISTANT, GRADE "B"

Required, 1st September, 1960, ASSISTANT, GRADE "B" to assist in MACHINE SHOP and to teach PRODUCTION ENGINEERING subjects, mainly for City and Guilds courses in Machine Shop Engineering, Intermediate and Final levels.

Candidates should have had good industrial and particularly workshop experience, and preferably some teaching experience.

Salary within the range : £738 to £1202 per annum.

Application form and further particulars (foolscap s.a.e.) from the Principal, to whom completed forms should be returned not later than the 30th June, 1960.

C. E. GURR, M.Sc., Ph.D.,
E5115 Secretary to the Education Committee.

HERTFORDSHIRE COUNTY COUNCIL

ST. ALBANS COLLEGE OF FURTHER EDUCATION AND HERTFORDSHIRE COLLEGE OF BUILDING

Principal : D. T. NEWMAN, J.P., B.Sc.

ASSISTANT

Applications are invited for the post of ASSISTANT, Grade "B" to teach Machine Shop Engineering to Intermediate City and Guilds standards. Candidates should be prepared to teach Workshop Practice and Technology with the associated Calculations, Science and Drawing. They should hold a C. and G. Full Technological Certificate or equivalent qualification. The appointment will take effect from 1st September, 1960, or as soon after as possible.

Salary : Burnham Technical Scale, Grade "D" : £700 by £27 10s. to £1150.

Application forms may be obtained by sending a stamped addressed envelope to The Principal, 29 Hatfield Road, St. Albans, Herts. E5147

ELECTRICITY SUPPLY BOARD (DUBLIN)

VACANCIES FOR STRUCTURAL DESIGN ENGINEERS (TEMPORARY)

The Electricity Supply Board has vacancies on its Civil Engineering Design staff at its Head Office in Dublin for

(a) Engineers not over 35 years of age with at least eight years' experience on the design and construction of civil engineering work, the major portion of which should be on heavy reinforced concrete and/or structural steel work : salary will be not less than £1009 per annum in a Scale rising by annual increments to a maximum of £1257 per annum.

(b) Engineers not over 30 years of age with at least four years' experience as set out above for (a) : salary will be not less than £817 per annum in a Scale rising by annual increments to £1162 per annum.

Candidates must possess a University degree in Civil Engineering or an equivalent qualification. Design experience on steam generating stations would be an advantage.

The commencing salaries within the above scales will depend on qualifications and the nature and extent of experience, but will be not less than the figures mentioned above.

The appointments will be on a temporary basis and are expected to continue for at least three years.

Applicants should clearly indicate the particular position(s) in which they are interested ; applications should set out the candidates' age and full details of their qualifications and experience (with dates) and should reach the Personnel Officer, 27, Lower Fitzwilliam Street, Dublin, not later than fourteen days from the date of this publication.

J. G. GARGAN,
E5156 Secretary.

PUBLIC APPOINTMENTS

UNIVERSITY OF SYDNEY

LECTURESHIP IN CIVIL ENGINEERING

Applications are invited for the above-mentioned position. Candidates should have a higher degree and have had some teaching experience in the subject Surveying.

The salary for a Lecturer is within the range £A1730 by £A105 to £A2435 per annum, plus cost of living adjustments (at present £A5 p.a.) and will be subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme, in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1

Applications close, in Australia and London, on 29th July, 1960. E5153

BRITISH COUNCIL

SCIENCE OFFICER (ENGINEER)

Vacancy in Grade Senior Scientific Officer. Appointment is normally on probation for permanent, world-wide service, with the prospect of promotion to senior posts. The officer serves initially in the Science Department in London, later in a science post overseas, eventually in general duties overseas or at home. (Alternatively appointment to London post only will be considered.)

The Council's work in Science (pure and applied) s, broadly, to make known overseas current scientific developments in the United Kingdom. In London the Science Officer will normally advise on his branch of the sciences ; when overseas on all scientific subjects (including medicine).

Candidates, preferably between 24 and 36, must be British-born British subjects, graduates with honours in Engineering, with corporate membership of I.C.E., I.Mech.E. or I.E.E. At least two years' post-graduate experience and broad scientific interests are necessary.

Present London salary scales (men) : Senior Scientific Officer £1233 to £1460 ; Scientific Officer (entry under age 26) £655 to £1150. Superannuation Scheme, with transfer arrangements. When overseas, also : Oversea allowance (married £700 to £1500 ; single £300 to £1,000, according to country), children's allowances, free accommodation, &c.

Write, quoting C.3EN (60) and enclosing a stamped addressed foolscap envelope, to Director, Recruitment Department, British Council, 65 Davies Street, London, W.1, for further particulars and application form, to be returned completed by 5th July, 1960. E5152

TEES VALLEY AND CLEVELAND WATER BOARD

CIVIL ENGINEERING ASSISTANTS AND DRAWING OFFICE ASSISTANTS

In connection with further development of the Board's Water Undertaking involving design and construction of a large Reinforced Concrete Service Reservoir of 30 million gallons capacity ; provision of additional river intakes, screens and pumping plant for river abstraction of a capacity of 25 m.g.d.; and the design and laying of trunk mains of sizes ranging from 45in. to 21in., at a total estimated cost of over £4 million, the Board has immediate vacancies for the following staff :

(a) FIVE CIVIL ENGINEERING ASSISTANTS at salaries in accordance with Local Government Engineering, etc. Scale (£785 to £1070 per annum) with salary according to experience. (Graduate Engineers would be considered for these posts.)

(b) FOUR DRAWING OFFICE ASSISTANTS at salaries in accordance with Local Government Miscellaneous V Scale (£650 to £715 per annum) with salary according to experience.

Applications, stating age, qualifications and experience, accompanied by names and addresses of two parties to whom reference may be made, or two recent testimonials, should be forwarded to reach the undersigned not later than Tuesday, 28th June, 1960.

E. A. MORRIS,
Clerk of the Board and Chief Executive Officer.

Water Board Offices,
Corporation Road,
Middlesbrough.
14th June, 1960. E5105

PUBLIC APPOINTMENTS

TEES VALLEY AND CLEVELAND WATER BOARD

AMENDED NOTICE

SENIOR ENGINEERING ASSISTANT AND ENGINEERING ASSISTANT

The Board, whose limits of supply extend over an area of 319 square miles, with a water demand of 41 m.g.d., in a rapidly expanding industrial area, invite applications for the following appointments in its Supply and Distribution Section.

(i) SENIOR ENGINEERING ASSISTANT. Salary within the range of A.P.T. V (£1220 to £1375) according to experience.

(ii) ENGINEERING ASSISTANT. Salary within the range of A.P.T. IV (£1065 to £1220) according to experience.

In each case applicants should be Corporate Members of the Institution of Civil Engineers.

For the Senior Engineering Assistant's post, consideration will be given to the provision of housing accommodation if required.

The appointments will be subject to the provisions of the Local Government Superannuation Acts, 1937-53, and the successful applicants will be required to pass a medical examination.

Applications, stating age, qualifications and experience, accompanied by two recent testimonials, should be addressed to reach the undersigned not later than Tuesday, 28th June, 1960.

E. A. MORRIS,
Clerk of the Board and Chief Executive Officer.

Water Board Offices,
Corporation Road,
Middlesbrough.
14th June ,1960. E5104

NORTH EAST DERBYSHIRE JOINT WATER COMMITTEE

TECHNICAL STAFF

Applications are invited for the following appointment on the staff of the Engineer and Manager.

The commencing salary will be in accordance with qualifications and experience.

The appointment offers good experience in Water works Design and Construction.

SENIOR ASSISTANT ENGINEER (A.P.T., Grade IV, £1065 to £1220).

Applicants must be Corporate Members of the Institution of Civil Engineers, and they should have had previous experience in the design and construction of service reservoirs, treatment plants and pumping stations.

Housing accommodation will be made available to the successful applicants and a car allowance will be paid up to 8 h.p. in accordance with the National Scale.

The post is superannuable and the successful applicant will be required to pass a medical examination.

Applications stating age, qualifications, experience and appointments held together with the names of two referees should be submitted to the undersigned not later than 2nd July, 1960.

H. O. HAWKINS,
Rural Council House, Clerk.
Saltergate,
Chesterfield. E5073

CHESHIRE COUNTY COUNCIL

CHESHIRE RIVER BOARD

DEPUTY COUNTY DRAINAGE OFFICER AND DEPUTY ENGINEER

Applications are invited for the appointment of DEPUTY COUNTY DRAINAGE OFFICER AND DEPUTY ENGINEER to the Cheshire River Board from corporate members of the Institution of Civil Engineers. Considerable land drainage experience is essential. The salary will be on scale £1550 to £1740, plus travelling allowance on the scale fixed by the County Council from time to time. The post is superannuable. Forms of application may be obtained from either of the undersigned and should be returned so as to be received not later than the first post on the 24th June, 1960.

A. C. HETHERINGTON,
Clerk of the Cheshire County Council.
HUGH CARSWELL,
Clerk to the Cheshire River Board.

County Hall,
Chester. E5086

Classified Advts. continued on page 118

PUBLIC APPOINTMENTS

WEST KENT MAIN SEWERAGE BOARD

APPOINTMENTS

(a) SENIOR ENGINEERING ASSISTANT (A.P.T. IV), £1065 to £1220 p.a.
(b) SENIOR ENGINEERING ASSISTANT Special Grade) £785 to £1070 p.a.
(c) GRADUATE ENGINEERING ASSISTANTS (TWO) (A.P.T. I) £700 to £765 p.a.
(d) JUNIOR ENGINEERING ASSISTANTS (TWO) (A.P.T. I) £610 to £765 p.a.
" London " allowance (£15-£45 p.a.) payable in addition.

The Local Government Superannuation Acts apply to these appointments. Applicants for the senior positions must be fully qualified ; positions (c) are intended for those graduating in civil engineering in this academic year, and will commence on 1st September ; juniors are required to have experience of civil engineering drawing office practice.

Applications, stating position applied for and giving full personal details, particulars of education, training and experience and the names and addresses of two referees, to William Howard, B.Sc., M.I.C.E., Engineer to the Board at 20, Blyth Road, Bromley, Kent, within ten days of publication of this advertisement.

A. J. W. JEFFERY,
Secretary of the Board.
E5108

WALES GAS BOARD

TECHNICAL HEADQUARTERS

DRAUGHTSMAN

Applications are invited for the above appointment in the Technical Headquarters Drawing Office located at Grangetown, Cardiff.

Candidates for the appointment must hold the Higher National Certificate in Civil or Mechanical Engineering or similar qualification, have had considerable experience in an Engineering Drawing Office, and be familiar with modern plant design and layout. Experience on Compressing, Governing and Storage Plant will be an advantage.

The salary for the appointment, which is pensionable and subject to Medical Examination, will be within Grade A.P.T. 9/10 (£827 to £1002) with initial placing according to qualifications and experience.

Applications, stating age, qualifications and experience, together with the names and addresses of two referees, should reach the undersigned not later than the 30th June, 1960.

C. B. MAWER,
Secretary.
2, Windsor Place,
Cardiff. E5151

MINISTRY OF AVIATION

PLUMSTEAD, LONDON

TECHNICIAN

Ministry of Aviation requires a TECHNICIAN at Plumstead, London, to assist in running the electro-mechanical section of a computer laboratory and supervising skilled staff. To perform critical examinations, check tests and sample inspection of electro-mechanical computer and fire control components and assemblies, and to write test reports. Some field work in climatic and mobility trials. Qualifications and Experience: Recognised engineering apprenticeship or equivalent training. O.N.C., appropriate City and Guilds Final Certificate, or equivalent qualifications. Good experience of testing precision mechanisms of anti-aircraft predictors and preferably have some knowledge of oil hydraulic servo gear. Salary : £720 (age 26) to £900 p.a. Application forms from Manager (P.E. 1907), Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. E5163

GERMAN HOSPITAL, LONDON, E.8.

(GENERAL, 157 BEDS)

APPOINTMENT OF ASSISTANT ENGINEER

Applications are invited for the above appointment, at a commencing salary of £625 to £660 p.a., rising to £765 p.a. The successful candidate, who may also be required to undertake relief work elsewhere in the Group, will be required to supervise and actively participate in the maintenance and operation of the hospital's engineering services (both mechanical and electrical) under the direction of the Superintendent Engineer. Candidates should have experience in the operation of oil-fired boilers, and possession of the Ordinary National Certificate in Mechanical Engineering will be an advantage.

Application forms, obtainable from the undersigned, should be completed and returned by 27th June.

JOHN B. MANNING,
Group Secretary.
Hackney Hospital, E.9.
June, 1960. E5149

CIVIL SERVICE COMMISSION

PATENT EXAMINERS AND PATENT OFFICERS

Pensionable posts for men or women for work on the examination of Patent applications. Age at least 21 and under 29 (36 for Examiners), with extension for regular Forces service and Overseas Civil Service. Qualifications : normally first or second class honours degree in physics, chemistry engineering or mathematics, or equivalent attainment, or professional qualification, e.g. A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C. London salary (men) £655 to £1460 ; provision for starting pay above minimum. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/128/60, and stating date of birth. E5130

PUBLIC APPOINTMENTS

CITY OF BIRMINGHAM EDUCATION COMMITTEE

APPOINTMENT OF ENGINEER

The Education Committee invite applications from suitably qualified persons for the post of ENGINEER at a salary in accordance with A.P.T. Grade IV (£1065 by £55 by £50 by £50 to £1220). Applicants must have passed the appropriate examination of the Institution of Heating and Ventilating Engineers, of Electrical Engineers or of Mechanical Engineers, or should possess at least one appropriate Higher National Certificate allied with five years' practical experience.

The duties include responsibility for the maintenance of the heating, lighting and allied installations at educational buildings. The successful candidate will be required to control maintenance contracts, to certify for payment the appropriate accounts and to prepare reports to Committee, etc. The Engineer may also be required to design schemes comprising improvements to existing heating and lighting installations and/or small extensions, and in this connection will also be responsible for the supervision of the work involved.

Applications containing details of qualifications, experience, age, present employment and present salary, and giving the names and addresses of two referees, should be addressed to the undersigned in an envelope marked " Post of Engineer," so as to be delivered not later than the first post on 28th June, 1960.

E. L. RUSSELL,
Chief Education Officer.
Council House,
Margaret Street,
Birmingham, 3. E5109

AIR MINISTRY

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

Air Ministry require ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS for design, construction and maintenance of installations on airfields, radar stations, missile bases, workshops and maintenance units for R.A.F. at home and overseas as well as certain Civil Airports. Salary : £805 at 25 to £1095 at 34 or over, thereafter rising to maximum £1260, with increase for London, and slight decrease for country districts. Appointments non-pensionable but long term. Promotion prospects. 5-day week with 4 weeks' 2 days' leave a year initially. Special allowance in addition to salary during overseas service. Qualifications and experience :

(i) (a) University degree or equivalent diploma in electrical and/or mechanical engineering with at least 2 years' apprenticeship ;
or (b) Graduate or corporate member of I.E.E. with at least 3 years' apprenticesnip ;
or (c) Graduate or corporate member of I.Mech.E., appreciable electrical engineering experience with at least 3 years' apprenticeship ;
and (ii) Have been employed for minimum of 2 years with well-established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects between ages of 25 and 45. Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.158/OA. E9850

ARCHWAY GROUP HOSPITAL MANAGEMENT COMMITTEE

ASSISTANT ENGINEERS (2)

required at Whittington Hospital, N.19. Applicants over 25 years of age preferred who should have completed practical training in Mechanical Engineering. Ordinary National Certificate for Mechanical Engineering or equivalent an advantage. Salary scale £570 to £700 per annum, plus £30 London Weighting at 26 or over. Successful candidates will be required to reside within reasonable distance of hospital. Department may be visited by direct appointment with Hospital Secretary, ARC. 3070, Ext. 254. Application forms obtainable from and returnable to Group Secretary, 46, Cholmeley Park, N.6, within 10 days.

E5141

TENDERS

INDIA STORE DEPARTMENT

TENDER REF. NO. 20010/60/MISC/HAL.2

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

TENDER REF. NO. 20010/60/MISC/HAL.2

Tenders are invited for HYDRAULIC FORGING EXTRUSION PRESS of capacity, 3000 tons, daylight 8 feet, minimum table size 5 feet by 6 feet.

The Tender forms with Schedules and Specifications which are returnable on the 11th July, 1960, may be obtained from the above office (C.D.N. Branch) on payment of a fee of ten shillings (not returnable) for each Tender.

The applications for Tenders should clearly state the above reference number. E5114

TENDERS

COUNTY BOROUGH OF BRIGHTON

WATER DEPARTMENT

PATCHAM PUMPING STATION

TENDERS invited for MANUFACTURE, DELIVERY, ERECTION, TESTING AND MAINTENANCE of THREE ELECTRICALLY DRIVEN SUBMERSIBLE WELL PUMPS and FOUR BOOSTER PUMPS with control gear and other Appurtenant Works.

Specification and particulars from Waterworks Engineer, 12, Bond Street, Brighton, 1, on payment of Five guineas deposit to be refunded on receipt of a bona-fide Tender and return of all documents.

Tenders in plain sealed envelopes not bearing any name or mark indicating the sender, endorsed " Tender for Pumping Plant, Patcham," to be delivered to me by noon on 29th July, 1960.

The Corporation do not bind themselves to accept the lowest or any Tender.

W. O. DODD,
Town Clerk.
Town Hall,
Brighton, 1.
June, 1960. E5062

INDIA STORE DEPARTMENT

TENDER REF. NO. 18001/60/BMB/HAL

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

TENDER REF. NO. 18001/60/BMB/HAL

CARRIAGE WHEEL SETS (5ft. 6in. gauge), complete with AXLE BOXES and CYLINDRICAL ROLLER BEARINGS—Quantity 400 sets.

The Tender forms with schedules and specifications which are returnable on 7th July, 1960, may be obtained from the above office (Co-ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Applications for Tender should specify the above reference. E5113

BRAINTREE & BOCKING U.D.C.

CODHAM MILL WATER SCHEME

CONTRACT NO. 8—PIPELAYING

The Council invite TENDERS from experienced Public Works Contractors, who specialise in PIPELAYING, for the laying of approximately 5½ miles of 9in., 10in., 15in. and 21in. spun iron pipes with flexible joints and the construction of ancillary works.

The General Conditions of Contract, Specification, Bill of Quantities, Form of Tender and Drawings, prepared by the Consulting Engineers, Messrs. Herbert Lapworth, Partners, 25, Victoria Street, Westminster, S.W.1., may be obtained from the Undersigned on or after Monday, 27th June, 1960, on payment of a cheque for £10 made out in favour of the Council, which amount will be refunded on receipt of a bona-fide Tender not subsequently withdrawn.

The Tender is to be returned addressed to the Undersigned in a sealed envelope endorsed " Tender for Codham Mill Water Scheme, Contract No. 8," and to reach the Town Hall on or before noon on Monday, 25th July, 1960.

The Council does not bind itself to accept the lowest or any Tender.

W. BALSON,
Clerk of the Council.
Town Hall,
Braintree, Essex. E5154

FYLDE WATER BOARD

TENDERS FOR PROPOSED TREATMENT PLANT

BROUGHTON BOREHOLE SCHEME

The Board is proposing to CONSTRUCT SOFTENING PLANT for the treatment of water obtained from their Broughton Borehole Scheme.

Firms desiring to be placed on the list of Tenderers should apply to the undersigned before Saturday, 16th July, 1960, giving particulars of similar work carried out during recent years.

Preliminary details are available, but full Tender documents will be issued only to the selected Tenderers.

The date for submission of Tenders is 6th January, 1961.

FRANK LAW,
B.Sc.Tech., M.I.C.E.,
Engineer to the Board.
Sefton Street,
Blackpool. E5161 T

BOROUGH OF CAMBERWELL

REPLACEMENT OF CALORIFIER AT CAMBERWELL BATHS

TENDERS invited for REMOVAL of existing Calorifier and redundant piping, and the FABRICATION, INSTALLATION and TESTING of a hot water receiver and all connections. Tender forms obtainable from Borough Engineer and Surveyor, Town Hall, Camberwell, S.E.5. Closing date 28th June, 1960. E5135

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus, free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

EDUCATIONAL

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

RESEARCH FELLOWSHIPS AND SCHOLARSHIPS

The Governors propose to make the following awards for the Academic Year 1960-61 :

RESEARCH FELLOWSHIPS, of annual value £750, tenable for a period of up to 3 years with a possibility of further extension. Applications are invited from persons, of either sex, who hold a degree, or equivalent qualification, have obtained some industrial or research experience, and are eager to carry out research, under the general supervision of an experienced research worker, in one of the fields of engineering—applied science, human sciences and natural sciences. Fellows may be invited to undertake a limited amount of occasional tutorial work or laboratory supervision for which they receive additional payment.

RESEARCH SCHOLARSHIPS, of annual value £350 to £500, according to age and circumstances, for a period of 3 years. Applications are invited from holders (of either sex) of a degree, or equivalent qualification, who wish to obtain research training whilst carrying out research work, in one of the above mentioned fields, in association with an experienced research worker, that may lead to a higher academic award. Scholars may be invited to undertake a limited amount of tutorial work and laboratory supervision.

Fellows and Scholars may reside in a Hall of Residence.

Applications should be made to the Academic Registrar, quoting reference 9/C. E5148 E

CITY AND COUNTY OF BRISTOL EDUCATION COMMITTEE

THE COLLEGE OF TECHNOLOGY, BRISTOL

A short course of lectures will be held at the College on Friday and Saturday, 24th-25th June, dealing with the subject of

" NEW MATERIALS OF THE NUCLEAR AGE "

Enrolment Fee : £2 2s.

Particulars and enrolment forms from the Organiser of Short Courses, College of Technology, Ashley Down, Bristol, 7. E5132 E

UNIVERSITY OF LONDON KING'S COLLEGE

TUTORIAL STUDENTSHIPS

are offered in the Departments of Civil Engineering, Electrical Engineering and Mechanical Engineering. The value is £425 a year, with free tuition, from 1st October, 1960. Applicants must be graduates or about to graduate, and will be required to read for a higher degree and to give a limited amount of assistance by demonstrating.

Particulars and forms from the Registrar, King's College, Strand, W.C.2, to whom completed applications should reach not later than July 4th. E5164 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

ASSISTANT TECHNICAL SALES ENGINEER required by old-established engineering firm in London. Previous sales experience unnecessary but good general education and sound engineering training essential with an engineering degree or H.N.C. Permanent position with good opportunities for advancement.—BOX No. E2897, " The Engineer." A

ASSISTANT WORKS ENGINEER (Mechanical) required by old-established manufacturing company in the Midlands (non-engineering product), with experience in the design, layout and installation of process equipment and factory services. Applicants will be responsible for the co-ordination of the departmental engineering sections and the preparation of estimates, and must be Corporate Member of the Institute of Mechanical Engineers. Age range 30-40.—Write, giving details of experience and salary to BOX No. E5133, " The Engineer."

CONSTRUCTION. Qualified Engineers with considerable experience pipeline, pumping station and tank farm construction required by leading international firm for Middle East.—Write Box No. 3478, c/o Charles Barker and Sons Limited, Gateway House, London, E.C.4. E5162 A

CONSULTANTS REQUIRE QUALIFIED ENGINEERS, aged 25-40, with experience of planning, production control, estimating and rate fixing. —BOX No. E2395, " The Engineer." A

DESIGN / DRAUGHTSMEN — Piping Layout, Piping Checkers, Piping Arrangements and Civil with specialised knowledge of Oil Refinery and Chemical plants for progressive positions in London Office of an expanding Anglo-Americ .n Company. Salaries commensurate with qualifications and experience. Comprehensive pension, life assurance, personal accident and other benefits.—Apply to McKee Head Wrightson Limited, 16-26, Baltic Street, E.C.1 (Phone CLE 4388). E5059 A

ENGINEERING DRAUGHTSMAN

required in the Engineering Drawing Office of the National Coal Board in London. Applicants should have O.N.C. or equivalent qualifications. A knowledge of mechanisms and mechanical handling equipment and experience of mining machinery would be an advantage. Appointment superannuable, salary according to qualifications and experience within £805 to £925.—Write for application form to Staff Dept. (X.1813/2B), N.C.B., Hobart House, London, S.W.1, before 27 June, 1960.

E5165 A

DETAIL AND SCHEME DRAUGHTSMEN required for Experienced Sheet Metal Work for Ventilating and Dust Recovery Plants, &c.—Phone : Visco., CRO. 4181. E5015 A

SITUATIONS VACANT

ENGINEER for Inspection of Cranes and Lifting Plant required by leading Insurance Company. Must have drawing office experience of design of Cranes, also National Certificate in Mechanical Engineering. Areas : South Essex and Liverpool. Starting salary £800—other benefits—not over 38 years—permanent.—Write Box E540 LPE, Romano House, 399-401, Strand, London, W.C.2. E5131 A

ENGINEERS required for service in West Africa by a Company within the Unilever Group operating Palm Oil Estates. Age limit 26 to 32. There are two appointments.

(A) FACTORY EQUIPMENT MAINTENANCE ENGINEER responsible for efficient maintenance and operation of factory and Estate equipment and also training of African staff. Experience should include staff control, operation of boiler plants, steam and i.c. power units, electrical installations and transport. Minimum qualifications : Graduate Inst.Mech.E. or equivalent. Electrical qualification an advantage. Commencing salary not less than £1600 p.a.

(B) TRANSPORT AND INSTALLATION ENGINEER responsible for efficient maintenance and operation of all transport including Estate Road, Bridges, Lorries, Tractors, Earth-moving equipment, small Diesel Locos., Electric Lighting installation, also small Rubber Factory. Duties may involve occasional visits to Nigerian Estates to inspect and report on condition of transport services. Commencing salary not less than £1200 p.a.

The Estates are situated in rather isolated areas, but free furnished accommodation is provided. In addition there are family allowances, a contributory Pension Fund and free passages.—Apply in writing, stating age, education, qualifications and experience to Staff Department, The United Africa Company Limited, United Africa House, Blackfriars Road, London, S.E.1. E5102 A

ESTIMATING DESIGNER/DRAUGHTSMAN required by a small but rapidly expanding Engineering Company. The work is of a varied and interesting nature, including light and heavy fabrications, general machining machinery design and lay-out, etc. Applicants should be able to discuss technical problems with customers and have proven ability for original design. Knowledge of hydraulics and/or pneumatics would be an advantage. Candidates, who should have workshop experience, age 25-35 possessing O.N.C. (Mech.) preferred, but older men would be considered, should write in the first instance giving age, experience and salary required to : Managing Director, Mepel Co., Ltd., 105 Fairfield Road, Bow, London, E.3. E2899 A

ESTIMATING ENGINEER for progressive position with prominent London firm of Land and Marine boiler engineers. Drawing office experience essential ; workshop experience an advantage. Attractive salary commensurate with experience and qualifications.—Write fully, stating age, &c., to BOX No. E5138, "The Engineer." A

GRADUATE MECHANICAL ENGINEER required by NATIONAL RESEARCH DEVELOPMENT CORPORATION, an organisation set up under the Development of Inventions Act, 1948, to develop and exploit inventions in the public interest. The work is administrative in nature and involves maintaining personal contact with research establishments ; assessing inventions ; arranging their development if necessary ; and finally securing their commercial use, generally through licence agreements negotiated with senior management of industrial firms. Progressive salary starting within the range of £1200 to £1500 according to age, qualifications and experience. Preferred age about 30. Superannuation Scheme.—Send postcard for application forms, etc., quoting REFERENCE F3, to Director of Administration, N.R.D.C., 1 Tilney Street, London, W.1. E5106 A

IMPORTERS REQUIRE REPRESENTATIVES already calling on Engineering Concerns to carry Welding Cutting Equipment and Machine Tools.—BOX No. E191, "The Engineer." A

INSTRUMENT ENGINEERS. This expanding Anglo-American Company offers progressive positions in an organisation dealing with design, engineering and construction of Oil Refinery and Chemical plants. They are required for work on preparation of specification for equipment associated with process control systems. Minimum qualifications : engineering degree or equivalent and 2 years or more experience in similar work. Salaries commensurate with qualifications and experience. Comprehensive pension, life assurance, personal accident and other benefits.—Apply to McKee Head Wrightson Ltd., 16-26, Baltic Street, E.C.1. (Phone CLE 4388). E5057 A

JUNIOR AND INTERMEDIATE DRAUGHTSMEN required for Project, Structural and Mechanical Handling Departments, minimum qualifications O.N.C. Experience in Structural and Bulk Material Handling Plants for Collieries, Quarries, Steelworks, &c. Good salaries, superannuation scheme and this year's holiday arrangements respected.—Apply Robert Cort and Son, Ltd., Reading Bridge Ironworks, Reading, marking envelope Ref. HF. E5052 A

LIFT ENGINEER. Lift Engineers required for the Erection and Servicing of Lifts in Nigeria and Ghana. Wide experience of this work is essential, and some knowledge of the more complicated high-speed installation would be an added advantage. Appointments are to be made to the permanent staff and there are also contract vacancies for periods of 24 months. Salary dependent upon experience and terms of engagement, but in the region of £1300 to £1500 per annum with free furnished quarters and generous allowances.—Full particulars of experience to BOX No. E5101, "The Engineer." A

MECHANICAL ENGINEER

required at the National Coal Board's Central Engineering Establishment, Stanhope Bretby, Nr. Burton-on-Trent. Applicants should have had a wide experience of medium to heavy mechanical engineering problems particularly on the design and development of new equipment. Some knowledge of materials handling and/or methods of dust suppression would be an advantage. Corporate membership of one of the Senior institutions is desirable.

Appointment superannuable, salary according to qualifications and experience within £900 to £1400.—Write for application form to the Administrative Officer (X.1746/2C) at the above address before 27th June, 1960.

E5125 A

MECHANICAL ENGINEER

If you have a good honours degree in Mechanical Engineering, plus Graduate or Associate Membership of the Institution of Mechanical Engineers and would like to join the Commonwealth's largest glass manufacturing organisation, you are invited to write about yourself to the Personnel Officer (Graduate Recruitment), Pilkington Brothers Limited, St. Helens, Lancashire.

You would be responsible direct to the Works Mechanical Engineer for the installation of new plant and improvement and maintenance of existing plant, including the Pilkington invented "Twin Grinder" licensed to flat glass manufacturers throughout the world. You would find ample scope for initiative and responsibility and there would be opportunity for early promotion within the Group.

E5103 A

MECHANICAL ENGINEERS are required by an expanding Anglo-American Company, offering progressive positions in an organisation dealing with design, engineering and construction of Oil Refinery and Chemical Plants. These positions call for specialised work in design of Petroleum and Chemical plants and equipment. Minimum qualifications B.Sc. and 2 years or more experience in this field. Salaries commensurate with qualifications and experience. Comprehensive pension, life assurance, personal accident and other benefits.—Apply to McKee Head Wrightson Limited, 16-26, Baltic Street, E.C.1. (Phone CLE 4388). E5058 A

PROCESS ENGINEERS are required by an expanding Anglo-American Company offering progressive positions in an organisation dealing with design, engineering and construction of Oil Refinery and Chemical Plants. These senior positions call for full responsibilities for Chemical Engineering design of large process units. Minimum qualifications : Honours degree Chemical Engineering and 5 years or more experience in this field. Salaries commensurate with qualifications and experience. Comprehensive pension, life assurance, personal accident and other benefits.—Apply to McKee Head Wrightson Ltd., 16-26, Baltic Street, E.C.1 (Phone CLE 4388). E5056 A

RESIDENT ENGINEER for reconstruction of the Swing Bridge at Caernarvon. Approximately 9-12 months appointment commencing July-August, 1960. Experience of welding essential. Salary £1000 per annum, plus expenses allowance. Applications giving full details of experience should be forwarded to the Consulting Engineers, F. R. Bullen and Partners, Dacre House, Dean Farrar Street, London, S.W.1. E5011 A

O. W. ROSKILL, Industrial Consultants, 14 Gt. College Street, S.W.1, have an opening for a young CHEMIST or CHEMICAL ENGINEER with a University education for technical market research and other consulting work. An unusual combination of scientific outlook and ability to draft well is required, together with wide rather than highly specialised interest in technological matters. E5126 A

PERA Machine Dynamics Section requires Honours Graduate for work on vibration studies of machine structures, and prototype machine tools. Applicants should have some knowledge of instrumentation and an interest in resolving experimental data into new design and development techniques. The work will involve collaborati..n with industry, and provide an excellent opportunity for a man with ability and initiative to make an important contribution to this field of activity. Good commencing salary with annual increments on merit, superannuation under F.S.S.U.—Applications to the Secretary (R.696), Production Engineering Research Association, Melton Mowbray, Leics. E5076 A

PRODUCTION ENGINEER required for Electrical Trade. Paddington area.—BOX No. E2893, "The Engineer." A

SALES REPRESENTATIVE

An expanding Engineering Company serving the Rubber and Plastic Industries seeks a sales representative to travel in the Outer Seven Countries. Must speak fluent German or French and have engineering sales experience. The appointment is London-based and salary will be according to experience and qualifications.—Apply in writing to BOX No. E5136, "The Engineer." A

SÃO PAULO LIGHT S.A.-SERVIÇOS DE ELETRICIDADE, a Company in Brazil and a subsidiary of the Canadian corporation, Brazilian Traction, Light and Power Company Limited, invite applications from suitably qualified men for the position of DEPUTY CHIEF of its PIRATININGA POWER STATION. The power station was completed about five years ago and is situated near São Paulo (population over 3 millions ; temperate climate, 2200 ft. above sea level). The plant comprised initially 2 by 100 MW, 1800 r.p.m. steam turbo-generator units each supplied at 850 p.s.i., 900° C. by one 850,000 lbs/hr. oil-fired boiler and has been recently expanded by the addition of two 125 MW. reheat units, 1800 p.s.i., 1000° F. Applicants should have sound technical knowledge and good practical experience in the administration, operation and maintenance of steam-electric power stations ; should also be of strong character with an aptitude for supervision and the maintenance of harmonious labour relations. Good salary, three years agreement with first class passage both ways ; four months paid leave after three years service. —Written application in the first instance should be made to Mr. Osborne Mitchell, General Manager, Canadian-Brazilian Services Limited, 9-12 Cheapside, London, E.C.2. E5127 A

STAFF VACANCIES due to extensive modernisation programme, plant and buildings.

ENGINEERING AND BUILDING DEPARTMENT

1. ENGINEERING DRAUGHTSMAN. Experience must include general plant layout with some design experience. Some workshop training an asset.
2. ARCHITECTURAL DRAUGHTSMAN. Experience must cover industrial type buildings generally. Work involves site supervision and liaison with Architects and Contractors.
3. SHIFT ENGINEERS (MECHANICAL). Some experience in a supervisory capacity relative to plant maintenance essential. Emphasis on first class practical training, including hydraulic and pneumatic plant and services.

In all cases a broad general, rather than specialised knowledge is essential. For (1) and (3) Iron and Steel foundry experience would be useful.

Vacancies are in the Derby area. First class working conditions and amenities. Profit sharing and pension schemes. Housing assistance would be considered where applicable.

Applications in writing, marking envelope "Works Engineer," giving full information relative to experience, technical training and salary required.

E5157 A

SUPERVISOR REQUIRED FOR STAINLESS STEEL SHOP. Must be fully experienced in the working and fabrication of stainless steel. Experience of general Sheet Metal Work and Polishing an advantage though not essential.—Apply in writing in first instance stating age, experience, qualifications and salary required to : Works Manager, JOHN C. CARLSON LTD., NEWMAN STREET, ASHTON-UNDER-LYNE, LANCS. E2887 A

TECHNICAL ADVISER required for Thermalite Ytong Limited, at their headquarters at Hams Hall, Warwickshire. The appointment will be as Deputy to the Chief Technical Officer, and duties will include giving technical advice to ARCHITECTS and CONTRACTORS on the use of the Company's material. A knowledge of Codes of Practice, British Standards, Bye Laws, etc., necessary, and applicants should hold A.M.I.Struct. E. qualifications or similar. Age 25-30 years.

The post, which is in a rapidly expanding Company, offers interesting work, and the appointment is progressive and pensionable.—Apply in the first instance to Personnel Manager (T.S.A.22), John Laing and Son (Holdings) Limited, Page Street, N.W.7.

E5134 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

BOOKS and PUBLICATIONS

PRINCIPLES OF SERVOMECHANISMS
By A. Tyers, A.M. Brit. I.R.E., and R. B. Miles, Grad. Brit. I.R.E.

The authors have written this book as a working aid for development and maintenance engineers. The book covers the functioning, performance, incorporation and setting up of these components. The electrical circuits are discussed in detail and the great quality of the work is that no mathematical knowledge beyond that of elementary trigonometry is required. Price 25/- net.

FACTORY ADMINISTRATION IN PRACTICE
By W. J. Hiscox and James Stirling, A.M.Mech.E.

Seventh Edition.

Part I of this volume, contains a very full and practical treatment of the administration of the production function of the light-engineering factory. The excellence of the work has led to its adoption as a class text-book for students of industrial organization in educational institutions throughout the country, and for several years it has been recommended to students preparing for the intermediate and final examination of the Institute of Costs and Work's Accountants by the Institutes Council.

Hiscox's work is complemented in Part II, a more comprehensive treatment of the broader aspects of factory administration. Price 18/- net.

PERSONNEL MANAGEMENT AND INDUSTRIAL RELATIONS
By Dale Yoder, Ph.D.

Fourth Edition.

This book is designed primarily for those already engaged in the sphere of personnel management and industrial relations but readers with little or no experience will find it a help towards understanding the problems, opportunities and challenges in this expanding field. Price 60/- net.

From all booksellers

PITMAN Parker St. Kingsway, London, W.C.2

Enter No. 1191 on reply card

DRAUGHTSMEN

Draughtsmen are required at the Midlands Research Station, Solihull.

The duties are interesting and will include work on the design of pilot and prototype plant associated with the development of new high-pressure processes for the production of town gas.

Candidates should possess at least an O.N.C. certificate in Mechanical Engineering.

The salary for the appointments, which are pensionable and subject to medical examination, will be within the range of £733–£927 per annum.

Applications, stating age, education and experience, should be addressed to the Industrial Relations Officer,

WEST MIDLANDS GAS BOARD,

6, Augustus Road, Edgbaston, Birmingham, 15.

E190 A

DRAUGHTSMAN

required by

NORTH THAMES GAS BOARD at WESTMINSTER, S.W.1.

for the design and detailing of reinforced concrete structures and foundations associated with gas works.

Higher National Certificate is a minimum qualification.

Starting salary according to qualifications and experience.

The appointment will be of a permanent nature and the successful candidate will be required to join the Board's contributory pension scheme.

Applications, stating age, qualifications and experience, should be sent to the Staff Controller, North Thames Gas Board, 30 Kensington Church Street, W.8., quoting reference TE/767.

E5127 A

GKN

The Guest, Keen and Nettlefolds Group of Companies

wish to make the following appointment in one of their constituent companies

INDUSTRIAL ENGINEER

The Production Manager of a Group Company which manufactures steel reinforcement and similar products, requires an Assistant to take part in the development of Work Study and systems of Production Control in the four works of the Company.

Applicants who should be aged about 30 must be qualified engineers, preferably with a degree, and should have had training and experience in Work Study methods. Experience of Production Control methods and plant layout would be an advantage.

Applicants should write, giving details of age, qualifications, career to date, etc., to the Group Personnel Officer, Guest Keen and Nettlefolds Ltd., 66, Cannon Street, London, E.C.4. All applications will be regarded as strictly confidential.

E5107 A

CRANE DRAUGHTSMAN AND DESIGNERS

required with mechanical or structural experience for design of all types of Overhead Electric Cranes. Permanent position with very good prospects, Pension Scheme and assistance with housing if necessary. Applications which will be treated in strict confidence to :

JOHN SMITH (KLY) LTD.,
CRANE WORKS, KEIGHLEY, YORKS.

E5047 A

Classified Advts. continued on page 120

SITUATIONS VACANT

M & L *have been retained to advise on the appointment of a*

WORKS MANAGER

(STRUCTURAL ENGINEERING)

for the structural steel department of a well-known and expanding group of companies.

The Works Manager will be responsible to the Director in Charge for the complete activity of the works which fabricates up to 1,500 tons of structural steel per month to specific orders.

The works is located in an attractive part of the country.

Candidates should have had practical experience of similar work in a managerial capacity. Preferred age 35-45. Salary £2,000/£2,500 (according to experience). Contributory pension scheme.

Please send brief details in confidence, quoting reference G.2450, to D. J. Clarkson. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

MANAGEMENT SELECTION LIMITED

17, Stratton Street, London, W.1.

E134 A

SITUATIONS VACANT

DRAUGHTSMEN

OXO LIMITED

invite applications for the following appointments in London:—

MECHANICAL DRAUGHTSMAN

for concentrated food section. Responsible for design and layout work in connection with food manufacture.

Previous experience of automatic and semi-automatic machine essential. Applicants should have H.N.C. or the equivalent qualification Quote Ref: D/O C.

RESEARCH & DEVELOPMENT DRAUGHTSMAN

Some experience in the chemical industry is desirable but not essential. Applicants should possess an O.N.C. or the equivalent qualification. Quote Ref: D/O.R.D.

DRAUGHTSMAN

for work on design and layout in connection with concentrated foods and preserves products and chemical preparations. Some electrical and/or building qualifications are desirable together with an O.N.C. or the equivalent qualifications. Quote ref: D/O.G.

All applicants should have served an indentured apprenticeship and be aged between 25 and 40 years.

The Company offers good working conditions including a five-day week, Superannuation Scheme, Staff Canteen and Sports and Social Club.

Please reply to:

Personnel Manager (Factories)
Oxo Limited
Hambro House
Queen Street Place
London E.C.4

giving ull details of qualifications, experience and salary required.

E5159 A

SITUATIONS VACANT

BRITISH OXYGEN GASES LIMITED

Development Group, HARLOW

British Oxygen Gases Limited have the following vacancies in their Development Group. The work is in connection with the development of equipment of a specialised nature in the compressed gases field.

DEVELOPMENT ENGINEER

Applicants should have a recognised technical qualification, preferably of pass degree or equivalent standard, as well as sound previous experience of design and development or experimental work in an appropriate direction. Familiarity with mechanical devices, scientific apparatus (not exclusively optical), instrumentation techniques, or systems involving the transfer of fluids would be an advantage.

TECHNICAL ASSISTANTS

Applicants should possess an O.N.C. or equivalent and have had some experience of test and experimental work of a nature parallel to that indicated above for the Development engineer post.

MECHANICAL DRAUGHTSMAN

Applicants must have a number of years' experience in the light engineering field, preferably with particular experience in a Development Drawing Office.
Housing assistance is available at Harlow.
There are good prospects as the activities of this section are expanding.

Write stating brief details to the

CHIEF DEVELOPMENT ENGINEER,
BRITISH OXYGEN GASES,
PINNACLES WOKKS, HARLOW.

E5142 A

Would you like to work in a peaceful atmosphere with beautiful country around you?

Group of Engineering Companies with modern offices in Hereford require:

(1) Technical and Commercial Sales Manager with experience of industrial air conditioning and refrigeration for home and export.

(2) Development Engineer.

(3) Sales Engineers.

(4) Refrigeration, Mechanical and Hydraulic Draughtsmen and Estimators.

5 day week. Contributory pension scheme. Applications, which will be treated in strict confidence, should be made in writing stating age, experience, salary required, &c., to Managing Director, Denco Works, Hereford.

E189 A

CJB

SENIOR MECHANICAL ENGINEERS

CONSTRUCTORS JOHN BROWN LIMITED

have vacancies for SENIOR MECHANICAL ENGINEERS who have had not less than 5 years experience in the Chemical/Petro-Chemicals Industries. A design and application experience in one or more of the following fields :—

PUMPS : HEAT EXCHANGERS ; TURBINES ; PRESSURE VESSELS and PIPING ; is essential.
Qualifications up to A.M.I.Mech.E./B.Sc. standard.

Apply in writing, giving full details, to the :

Personnel Manager
CONSTRUCTORS JOHN BROWN LTD
CJB House, Eastbourne Terrace, Paddington, London, W.2.
Please quote Ref. No. J.7055

E5140 A

TEXACO TRINIDAD, INC.

requires a

PIPING AND PROCESS EQUIPMENT DRAUGHTSMAN

for service in TRINIDAD

Applicants must hold a Higher National Certificate in Mechanical Engineering or an equivalent qualification, and Graduate or Associate Membership of the Institution of Mechanical Engineers is desirable. They should have served a mechanical engineering apprenticeship with manufacturers of high pressure boilers or of pressure vessels and allied equipment for the petroleum refinery or chemical industries, with emphasis on fabrication and drawing office work. Subsequent experience should consist of seven or more years in the design and detailing of pressure vessels and piping to Code requirements, and of non-pressure vessels and tanks including pipe stressing. They should be able to apply API-ASME Codes and to lay out process plant equipment and piping. Some experience as a section-leader with responsibility for organising and progressing work is essential.

Applicants should hold a current driving licence and be between the ages of 27 and 35. The starting salary for this appointment will be up to £1,600 p.a. according to qualifications and experience, and subsidised accommodation, schooling for children and long leave in this country at the end of each three year tour are provided.

Please write with brief particulars in the first instance to :—

The Personnel Officer, Trinoil (U.K.) Limited
29/30 Old Burlington Street, London, W.1
(Please quote J.43)

E5139 A

CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH and DEVELOPMENT DEPARTMENT

Applications Branch

MECHANICAL ENGINEER—STEAM OR GAS SYSTEMS

A vacancy exists for a **QUALIFIED MECHANICAL ENGINEER** with experience in the development of power systems employing steam or high temperature gases, which has brought him into close association with the design of equipment and test plant.

The successful candidate will be a member of the Section responsible for the design of experimental plant for large scale test and development work in projects providing wide scope and interest in mechanical engineering and other fields. **THE SECTION WILL BE LOCATED AT GUILDFORD.**

This opportunity is of interest to men possessing a Degree in Mechanical Engineering and having at least ten years' experience since graduation, including a substantial period spent in a Research or Development establishment, on projects in which steam or gas is used as the working fluid for power generation or heat exchange. Applicants should be confident of their ability to design complete steam or gas flow test plants in collaboration with colleagues in the experimental Sections, and provide detailed information to draughtsmen preparing manufacturing drawings.

The starting salary will be within the range £1,195 to £1,775 per annum.

Applications stating age, qualifications, experience, present position and salary to the Personnel Officer, 24/30, Holborn, London, E.C.1., by 27th June. Envelopes should be marked "Confidential Ref Eng/217."

E5123 A

SITUATIONS VACANT

W. H. ALLEN SONS & CO. LTD.
require a
FULLY QUALIFIED DESIGNER
for their
DIESEL DESIGN DEPARTMENT
to undertake the position of
ASSISTANT to the CHIEF DESIGNER

Applicants, aged between 35-45 years, should have experience in the design and operation of two and four stroke industrial and marine Diesels ranging from 200 to 2000 horse power and operating at speeds between 350 to 1000 r.p.m.

The Company offers excellent conditions of service, a contributory Pension and Life Assurance scheme together with a comprehensive range of welfare and recreational amenities. Assistance will be given towards the expense involved in moving to the Bedford area.

Applications, which will be treated in the strictest confidence, should be made in writing, giving details of age, past experience, present salary, etc., and quoting reference number 301/2 to :—

THE PERSONNEL MANAGER
QUEENS ENGINEERING WORKS, BEDFORD.

E5037 A

SITUATIONS VACANT

PUMP DESIGNER/DRAUGHTSMAN
and
DRAUGHTSMAN
required immediately
for the expansion programme
of
THE HOWARD PNEUMATIC ENG. CO. LTD.,
Fort Road,
EASTBOURNE

First class knowledge of pump elements, rotary and reciprocating, is essential. Field knowledge of application and plant layout experience in chemical, petroleum or food industry an advantage.

H.N.C. for senior, O.N.C. for junior post desirable, but sound practical experience following engineering apprenticeship is of greater importance.

These are challenging opportunities for men with the right enthusiasm and ability. Pension scheme in operation.

Apply in writing, stating fullest details of education, training and experience, with salaries earned.

E5117 A

SITUATIONS VACANT

EXCEPTIONAL OPPORTUNITY
for
YOUNG DESIGN ENGINEER (Age 25-30)

with H.N.C. and some years' experience, to develop his potentialities with a virile and expanding organisation. Knowledge of steel structures and electrical control systems desirable.

● GENEROUS SALARY RANGE ● PENSION SCHEME ● INTERESTING & VARIED WORK ● CONGENIAL ATMOSPHERE ● TRAVEL OPPORTUNITIES

Write or telephone for interview to :
THE TITAN LIFT CO. LTD.
PANCRAS RD., LONDON, N.W.1
Telephone: TERminus 5138

E5119 A

TEST ENGINEERS

TEST ENGINEERS are required for work in connection with the British Nuclear Submarine Programme at Barrow-in-Furness and near Thurso, Caithness.

Applications are invited from men whose technical standard is at least H.N.C. and who should be capable of operating conventional steam machinery and analysing test results. Sea-going or power station experience would be an advantage.

Successful applicants would be required to join the Company's Contributory Superannuation Scheme when eligible. Applications which will be treated as strictly confidential should give full details of qualifications, experience and current salary, and be addressed to :

The Manager,
Marine Propulsion, Research and Development Dept.,
VICKERS-ARMSTRONGS (ENGINEERS), LTD.,
Naval Construction Works, Barrow-in-Furness. E5121 A

SENIOR ENGINEERING DESIGN DRAUGHTSMEN

are required for (1) plant layout and (2) mechanical design, for steelworks or heavy and medium industrial projects. The appointments are for qualified and experienced men, and will carry attractive salaries with a contributory pension scheme. Some travelling will be involved. Applications should be marked "Plant" and addressed to the Personnel Manager,

W. S. ATKINS AND PARTNERS
158, VICTORIA STREET, LONDON, S.W.I.

E5160 A

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

ENGINEERS AND PHYSICISTS

Several posts with salaries between £1300 and £1800 rising to £2100 p.a. are available at the Rutherford High Energy Laboratory, Harwell, in the team which is being expanded to develop the potentialities of the 50 MeV Proton Accelerator recently commissioned there. A concentrated programme combining interesting physics/engineering research with important engineering development on a large scale is envisaged which should appeal to engineers and physicists who have the following qualifications, experience and interests.

1. A good Honours degree in Physics or Electrical Engineering or high attainments in comparable professional examinations.
2. Have experience in high or medium energy physics research and who now wish to concentrate on machine development.
3. Have experience, since graduating, in research and development in
   High power radio-frequency supplies (200 to 400 Mc/s)
   Modulator design
   High vacuum techniques
   Particle dynamics.
4. Have been concerned with prototype engineering in the electro-mechanical field requiring understanding of physical processes involved and a fundamental design approach.
5. Would prefer to work for a National Institute promoting fundamental research and having direct contact with universities and other research organisations in their field.

Candidates should preferably be between 27 and 35 years of age.

Salary will be progressive within the ranges quoted.

Send POST CARD for details to Personnel Manager (1720/25), U.K.A.E.A., A.E.R.E., Harwell, Didcot, Berks.

E5112 A

MANAGEMENT CONSULTANTS

QUALIFIED ENGINEERS with personality and drive are invited to apply for appointments available in the autumn. The work is extremely interesting and covers a wide range of industrial problems. It offers experience, remuneration and status equal to senior executive positions in industry and there is ample scope for advancement and opportunities for service abroad if desired.

The work includes the development and introduction of :—
Factory layout, mechanical handling and automation
General organisation and production control
Purchasing, stock control and stores organisation
Planning engineering, methods and work study
Incentives, training and personnel administration
General business and project surveys in a wide range of industries and often in conjunction with marketing, technical or financial consultants.

Applicants should be aged 26—35 with a good general education and should possess a university degree or equivalent qualifications. Remuneration includes cash profit sharing and generous non-contributory pension scheme with life cover. Replies, which will be treated in confidence, should include brief personal details and should be addressed to :—

PRODUCTION-ENGINEERING LTD.,
12 Grosvenor Place,
London, S.W.1.
quoting reference QJ. E5120 A

DEVELOPMENT ENGINEER

Applications for the post of Senior Development Engineer are invited from chartered Mechanical or Civil Engineers, preferably experienced in High Vacuum metallurgy and design work. The advertising Company is engaged in developing vacuum furnace and high vacuum equipment activities, and the post will involve both the approval of specifications and estimates for equipment and the control of production for subsequent contracts. An ability to apply modern production techniques is therefore necessary. This new appointment by an expanding and progressive engineering concern, will be located in Lancashire ; it will command a good salary.

Applications must detail age, education, academic qualifications, experience, and should be addressed to :

Ref. 455,
The Wallace Attwood Company,
Chantrey House,
Eccleston Street,
London, S.W.1,

who are acting on behalf of the Company in the first instance.

E5111 A

Classified Advts. continued on page 122

SITUATIONS VACANT

TECHNICAL SALES REPRESENTATIVE FOR LONDON AREA

Manufacturer of all types of Electric Overhead Travelling Cranes seeks applications from suitably qualified candidates for the above senior position which becomes vacant on the promotion of the present holder to Sales Manager.

Technical training will be arranged if necessary, and early interviews will be made in London and / or Bristol.

Applicants should write fully (in confidence) to:

SALES MANAGER,
REED CRANE & HOIST CO. LTD.,
LODGE CAUSEWAY, FISHPONDS, BRISTOL.

E5171 A

SENIOR PRODUCTION ENGINEERS
are required by
W. H. ALLEN SONS & CO. LTD.

Due to expansion, vacancies exist for additional Senior Production Engineers capable of originating and developing improved manufacturing techniques over a wide range of products on a one off and small batch basis.

Applicants must have experience in the manufacture of one or more of the following:

STEAM TURBINES
DIESEL ENGINES
ELECTRICAL MACHINERY

These appointments carry high responsibility and offer good prospects for further advancement. The Company offers good conditions of service, a contributory Pension and Life Assurance Scheme and a comprehensive range of welfare and recreational amenities. Assistance towards the expenses involved in moving to the Bedford area will be given to successful applicants where applicable. Salary will be according to qualifications and experience.

Applications, which will be treated in the strictest confidence, should be made in writing, quoting the reference number, to:—

The Personnel Manager (Ref. 1604E/19)
Queens Engineering Works, Bedford.

E5035 A

THE HOWARD PNEUMATIC ENG. CO. LTD.
Fort Road,
EASTBOURNE

requires immediately a keen

SALES ENGINEER

with good technical knowledge of application and installation of rotary and reciprocating pumps as used in the chemical, petroleum and food industries.

For a well qualified young engineer this is an exceptional opportunity to join in the expansion programme of an old established company, but there is no age limit. Pension scheme in operation.

Apply in writing, giving fullest details of training and experience with earnings expected.

E5116 A

ARE YOU A QUALIFIED ENGINEER

with practical experience, a scientific bent and an enquiring mind?

We are looking for such a person, age 25-35, to undertake research on the fundamental aspects of grinding. Minimum qualification is H.N.C. or equivalent in Engineering.

This is a good opportunity in an aspect of our work which is expected to expand, and prospects for the right man are therefore excellent.

First-class conditions of service, including contributory pension and life insurance scheme.

Please apply, giving age and full details of qualifications and experience to:—

Personnel Manager,
Universal Grinding Wheel Co., Ltd.,
Stafford.

Applications treated in strictest confidence.

E5158 A

SITUATIONS WANTED

COMPANY MANAGER (47), A.R.T.C., A.S.M.A., returning to U.K. from Africa in July seeks position in SALES or MANAGEMENT. Experienced in Earthmoving, Mechanical Handling, Hydraulics and Electrical Equipment. Widely travelled in Europe, Africa and Far East.—Enquiries please to BOX No. E2888, "The Engineer." B

DESIGN ENGINEER, experienced diesel locomotives, steel fabrication work, engine installations, technical publications, excellent record, travel anywhere, now resident Scotland.—BOX No. E2894, "The Engineer." B

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone: Knottingley 2743/4). E116 MW

MISCELLANEOUS

LUSOL
KILLS RUST AND LUBRICATES

LUSOL The Rust Solvent is invaluable for Dismantling, Repairing and Overhauling Engineering Equipment. Obtainable from your usual Supplier. Enquiries to the manufacturers:—

The Great Eastern Oil Co., Ltd.,
372, Scotland Street Glasgow. Tel.: South 2207
E184 I

TIME RECORDERS, Sales, Rentals, Service, Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157–159, Borough High Street, London, S.E.1. E110 I

BUSINESS OPPORTUNITIES

REMPLOY SPONSORSHIP SCHEME

Send for details which show an attractive proposition to manufacturers.
Write to the MANAGING DIRECTOR, REMPLOY LTD., 25-28, BUCKINGHAM GATE, S.W1, or telephone VICtoria 6621 (12 lines).

E9665 O

A BARGAIN. £25 complete. BRAND NEW READY-MADE CO. REGNS. Guaranteed no trading (ENGLAND OR SCOTLAND)—all trades available NOW, including Engineering; Electrical Engineering; Motor Engineering; Garage; Machinery; Metal; Haulage; Hire Purchase; Investment; Property (specially prepared for each trade).—BUSINESS ECONOMY CO. REGNS., LTD., Dept. T/16, 156, Strand, London, W.C.2. (Tem. 8377/2294), for English companies, and to 19, Walker Street, Edinburgh, 3 (Cal. 1167/8/9), for Scottish Companies. Read "ADVANTAGES OF TRADING AS A LIMITED COMPANY" (3s. post free); Limited Co. may save you tax. We have seven-day Co. Regn. service with your own choice of name. £21 complete, plus stamp duties. E182 O

BUSINESSES and PREMISES

SMALL PRECISION ENGINEERING BUSINESS situated London area, for sale, outright, or working partner would be considered.—BOX No. E5110, "The Engineer." L

AGENCIES

AGENT wanted for progressive company manufacturing open type steel flooring, steel staircases steel fabrications. Territory, Cheshire, Lancashire and the West Riding of Yorkshire. Must have connections with nationalised industries, consultants, oil refineries and general engineering companies.—Write, giving full details to BOX No. E2898, "The Engineer." D

FOR HIRE

LATTICE STEEL ERECTION MASTS (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. E103 K

MOBILE LIFTING SERVICE. Lump Sum or Hire Rate quoted for any lifting work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 78481. E188 K

MACHINERY Etc. WANTED

ONE 1000kW 520 VOLT., D.C., 500 R.P.M. COMPOUND WOUND INTER-POLE GENERATOR. Two bearing machine preferred.—BOX No. E5145, "The Engineer." F

ONE 1200 H.P., 460/500 VOLT., D.C., 100/120 R.P.M. COMPOUND WOUND INTER-POLE MOTOR. Two bearing machine preferred.—BOX No. E5146, "The Engineer." F

FOR SALE

FOR SALE, 3-ton Coles Diesel Electric Mobile Crane, Jib 15ft. 9in., new 1953.—Offers to The Manager, The British Aluminium Co. Ltd., Kinlochleven, Argyll. E5129 G

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p.; reconditioned 8ft. 6in. down to 3ft. dia.: Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p.; 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised; and several others of various makes and capacities.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.

MOBILE ROAD CRANES.—10-ton Lorain lorry-mounted 30ft.–70ft. extendible jib; 10-ton 33 R.B. track-mounted, 40ft. jib; 8½-ton Ransome Diesel/Electric, 21ft. jib; 6-ton Coles Diesel/Electric, solids; 4-ton Coles Diesel/Electric, solids, 1945; 4-ton Jones KL44, diesel, 1950; 3-ton Jones "Super 40" diesel, pneumatics (3).

OVERHEAD CRANES.—20-ton Vaughan, 42ft. 3in. span, 6-ton auxiliary, cab control (5); 20-ton King, 42ft. 3in. span, 400/3/50; 15-ton Booth, 37ft. span, 400/3/50; Wharton 7½-ton, 25ft. span, 400/3/50; 5-ton Henderson, 24ft. 7in. span, 1946; 5-ton Morris, 58ft. span, hand-operated; 5-ton King, 29ft. 3in. span, power hoist, hand travel; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel; 4-ton Morris, 19ft. span, 220V. d.c. (3); 2-ton Vaughan, 27ft. 6in. span, 2-motor; majority of the above are unused.

DERRICK CRANES.—7-ton Anderson Grice, 100ft. jib, electric; 7-ton Rushworth, hand, 30ft. jib; 1½-ton Anderson Grice, hand, 40ft. jib; 5-ton Butters Grabbing, 80ft. jib, electric.

RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib; 10-ton Grafton, 34ft. jib, diesel conversion; 8-ton Wilson, steam, 35ft. jib; 5-ton Grafton, 35ft. jib, diesel conversion; 5-ton Smith, 50ft. jib (2).

LOCOS.—Fowler diesel, 150 h.p. (2); Barclay & Ruston, 80/88 h.p., diesel; Bagnall 14in. by 22in. (two oil-fired, one coal), Peckett, steam, 7in. by 12in., 1941; 4 Logan Battery-operated, 24in. gauge, 3-4 ton cap.; 3 Ruston diesel 16/20 h.p., 24in. gauge; also 2 miles 20 lb. and 1200 yds. of 25 lb × 24in. gauge track, Bogies, Wagons, &c.

STEELPIPING.—Large stocks including following: 20,000 t. 1½in. galvanised "A,"; 20,000ft. scaffolding; 30,000ft. 3in. black; 15,000ft., each 6 n, 3/16in., ¼in., 5/16in., unused; 5000ft., 8in. unused; 2000ft., 10in., 12in., 16in., seamless; 200ft., 24in. by ¼in. welded, unused; 1000ft., 30in. by ¼in. welded, unused; 2500ft., 27in. welded flanged; 500ft., 36in. unused; 500ft., 42in. by ¼in. riveted; 100ft., 48in. by ¼in. welded unused; 150ft., 60in. welded; 20in., 24in., 26in., 27in., 28in., bitumen lined, unused. Full list on request.

CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s., including 150 by 18ft. lengths, 6in. Stanton class "B" Spigot and Socket, unused. Immediate delivery.

VALVES.—Exceptional Surplus Ministry Lot. New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock all sizes, Parallel Slide Sluices, Gunmetal, Reducing and Check Valves. List on request.

STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

MACHINE TOOLS.—Heenan & Froude Dynamometers, 1500 h.p. maximum, 18in. Dial Indicator (three); Scriven Plate Bending Rolls, 14ft. by ¼in.; Berry Bending Rolls, 7ft. by ¼in.; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table; Herbert Miller, 61in. by 15in. table; Pels Punch and Shears, ¼in. capacity; nine new 2 cwt. and 1 cwt. Pneumatic Hammers; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore; 40kVA. Sciaky Spot Welding Machine; Berry Guillotine, capacity 4ft. by 1in.; Fielding Hydraulic Tube Bending Machine, 24in. stroke up to 8in. capacity; Sedgwick 6ft. by ¼in. Folding Machine; Rushworth Guillotines, 6ft. by ¼in., and 4ft. by ¼in.; Bliss 70-ton power press.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone: Coleford 2271/2. E106 B

600

SPECIAL OFFER

MODERN ELECTRIC OVERHEAD TRAVELLING CRANES

at very attractive prices for immediate clearance from site, Swansea.

5-ton capacity, 55ft. 3in. span Crane by Craven Bros., arranged for cab control.

5-ton capacity, 47ft. 1in. span Crane by Craven Bros., arranged for cab control.

Also available: ex stock:

5-ton capacity, 48ft. span Crane by Anderson-Grice, arranged by cab control (two available).

1-ton capacity, 28ft. 4in. span Crane by Morris, arranged for cab control.

All cranes suitable for electric supply 400/440 volts, 3-phase, 50 cycles.

GEORGE COHEN,
SONS AND CO. LTD.,
600, WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070

E202 G

FOR SALE

SERVICE EDWARDS VALUE!

Plate Bending and Straightening ROLLER, self-contained motor drive, with 3 rollers arranged tripod fashion and fourth roller on one side for straightening, capacity 20ft. by ½in. plate, diameter of top roller 17½in., bottom rollers 15in., side roller 14in., weight approximately 42 tons.

TWO NEW BESCO Type F, Hand-Operated Universal Swing Beam Folding Machines, with high lift clamping beam and adjustable bed, maximum working length 80½in., capacity mild steel 14 S.W.G., height of lift of clamping beam 6in., weight approximately 27½ cwt.

RHODES Motorised Double-Geared Press Brake, motorised for 400/3/50 supply, pressure exerted 150 tons, forming capacity 10ft. by 3/16in. or 18ft. by approximately ¼in., length of stroke 5in., weight approximately 20 ton.

RHODES Model 1036, 150-tons Double Geared Press Brake with nickel-chrome reinforced cast iron frames, the bed and top beam are of rolled steel plates, pressure about 150 tons, forming capacity 10ft. 6in. by 3/16in. plate, width between housings 8ft. 8in., arranged motor drive 400/3/50, weight about 16 tons.

RHODES Geared Open End Guillotine, capacity 6ft. by ¼in. mild steel, fitted with automatic hold-down and all gauges, arranged motor drive 380/420/3/50.

TAYLOR & CHALLEN No. 6GDP, Double-Sided Double-Action Toggle Drawing Press, blankholder stroke 9in., punch stroke 15½in., machine surface of bed 32in. diameter, hole in bed 24in. diameter, size of punch 16¾in. by 13in., size of blankholder 28in. by 32in., complete with "Udal" automatic safety guard, arranged motor drive 440/3/50.

BLISS No. 85, Double-Geared Double-Sided Reducing Press with straight sides, pressure about 50 tons, stroke 14½in., with spare crankshaft for 5in. stroke, between uprights 22in., ram to bed 23in., bed 21in. by 21in., arranged motor drive 400/3/50.

Photographs of the above are available.

Very favourable Hire Purchase terms can be obtained.

MACHINE TOOLS, NEW AND USED, Of Every Description. Attractive Prices.

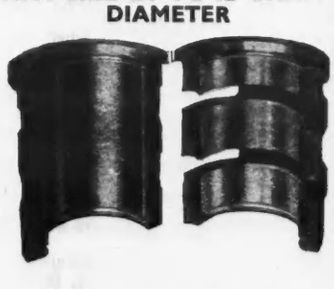
F. J. EDWARDS LTD.
359-361, EUSTON ROAD,
LONDON, N.W.1.
Telephone: Euston 4681-3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET, BIRMINGHAM, 3.
Telephone: Central 7606-8. E207 O

When getting down to it— *remember* WARDS *might have it!*

THOS. W. WARD LTD
ALBION WORKS, SHEFFIELD.

BEARING RECONDITIONING

ANY SIZE UP TO 12" SHAFT DIAMETER



Wheatley & Whiteley
99, Kirkstall Rd., Leeds, 3 Tel. 31122

Enter No. 1221 on reply card

AUCTIONEERS & VALUERS

By Order of the Receiver, C. E. M. Emmerson, Esq., F.C.A. Re : Measure Bros. (1911), Ltd.
WELHAM GREEN, HATFIELD.

Henry Butcher & Co.
are instructed to offer for SALE BY AUCTION in LOTS at THE WORKS on
THURSDAY, 7th JULY, 1960,
at ELEVEN A.M. the

PLANT AND MACHINERY
of
STRUCTURAL STEELWORKS ENGINEERS
including
"TOWE" AND "ASQUITH" 6FT. RADIAL DRILLS
PUNCHING, SHEARING AND CHOPPING MACHINES
"NOBLE AND LUND" FLUIDFEED COLD SAWS
RADIAL GIRDER DRILLING MACHINES
S.S. & S.C. LATHES. GRINDING MACHINES
BINDING AND STRAIGHTENING MACHINES
PORTABLE WELDING TRANSFORMERS
Power and Screw Fly Presses. Shearing Machines
Flexible Grinders. Saw Sharpeners
Welding Equipment
ROLLER CONVEYOR AND TRACK
STRAIGHT LINE AND PROFILE CUTTERS
OVERHEAD TRAVELLING CRANES
RIVET OIL-FIRED FURNACES AND FORGES
AIR COMPRESSORS PNEUMATIC YOKES
"ANDERSON" AND "BUTTERS"
ELECTRIC DERRICK CRANES
ENGINEER'S SMALL TOOLS AND CONSUMABLE STORES
"JONES" SUPER FORTY DIESEL MOBILE CRANE
Benches. Storage Racks and Tanks. S.C. Stoves.
OFFICE FURNITURE AND EQUIPMENT
SALOON CARS, VANS AND LORRIES
by Lagonda, Austin, Ford, Dennis and Wolseley.
Catalogues (when ready) may be obtained of :
Messrs. Josolyne, Miles and Co., Chartered Accountants, 28 King Street, Cheapside, E.C.2., and of
Messrs. Henry Butcher and Co., Auctioneers, Valuers and Surveyors of Factories, Plant and Equipment, 73 Chancery Lane, London, W.C.2.
Telephone : HOLborn 8411 (8 lines). E5155 J

FOR SALE

SOAG

LOW COST, HIGH QUALITY
LATHES
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June 30	Miscellaneous stores.	M.O.A. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT LTD., (Dept. L), 20 King Street, Hereford. (Tel.: 4366).
July 5–6	Machine tools and miscellaneous stores.	M.O.A. Storage Depot, Royal Arsenal, Woolwich, London, S.E.18.	FULLER, HORSEY, SONS & CASSELL, (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861).
July 12–15	Vehicles, motor cycles, earth moving and lifting equipment.	M.O.A. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON, (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272).
July 15	Miscellaneous stores.	Returned Stores Group, Reed Hall, Colchester, Essex.	FENN, WRIGHT & CO., (Dept. L), 146 High Street, Colchester, Essex. (Tel.: 3171).
July 19	Miscellaneous stores and vehicles.	Central Ordnance Depot, Bicester, Oxon.	MIDLAND MARTS LTD., (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73).
July 26	Machine tools and miscellaneous stores.	M.O.A. Storage Depot, Byley, Nr. Middlewich, Cheshire (Sale at Cheetham Town Hall, Manchester 8.	J. H. NORRIS & SON, (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373).
August 16	Miscellaneous stores.	M.O.A. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON, (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272).

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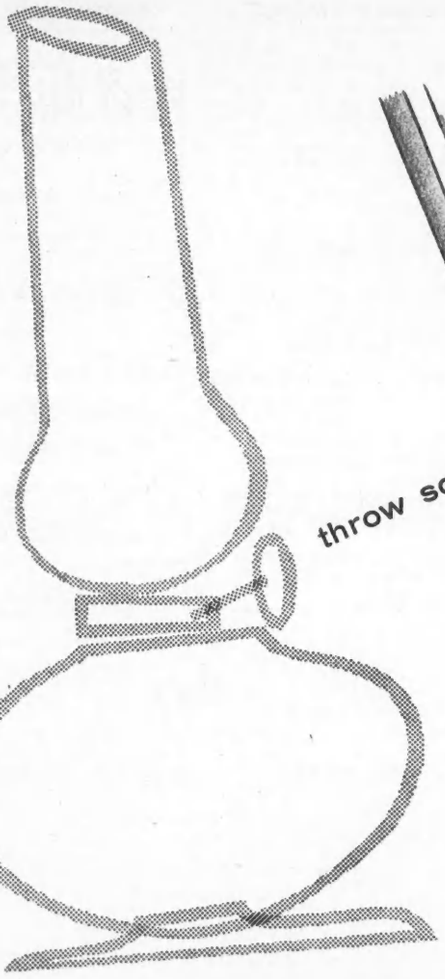

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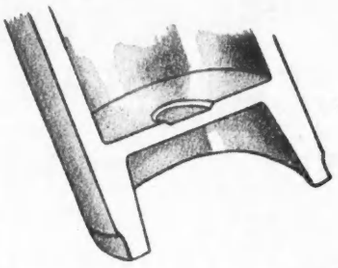

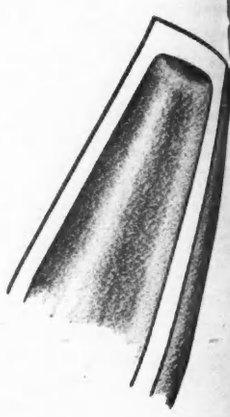

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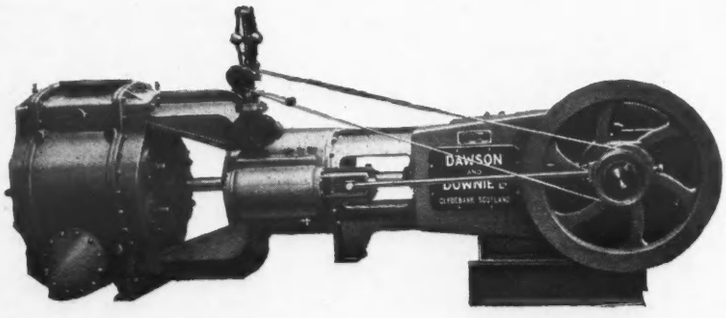

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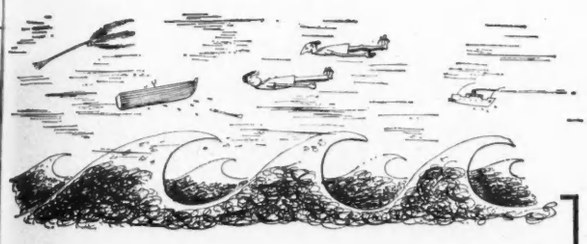

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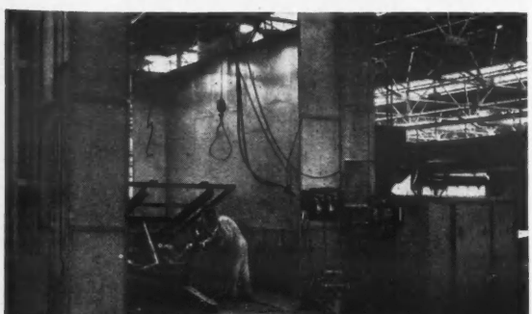

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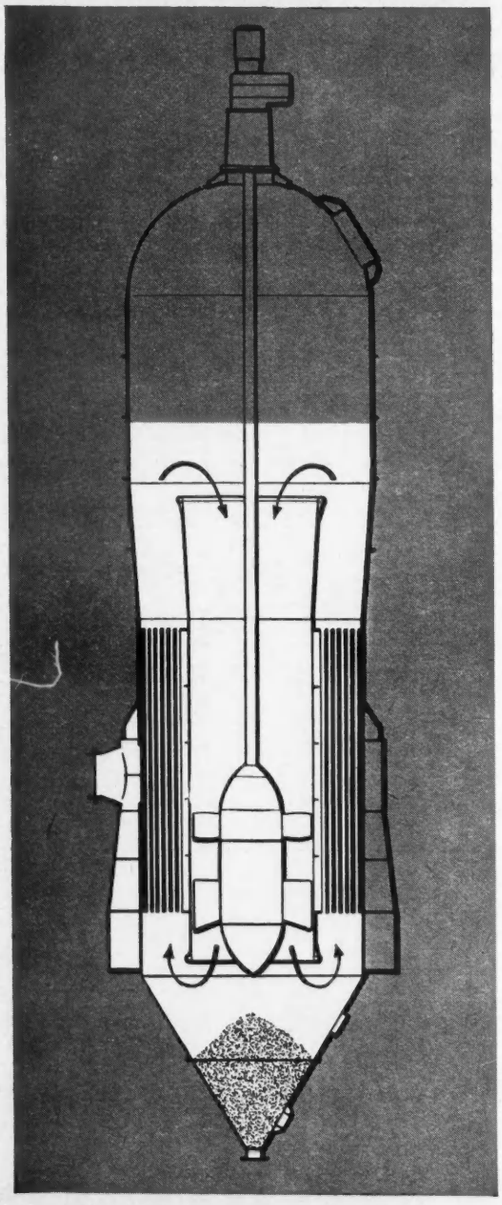

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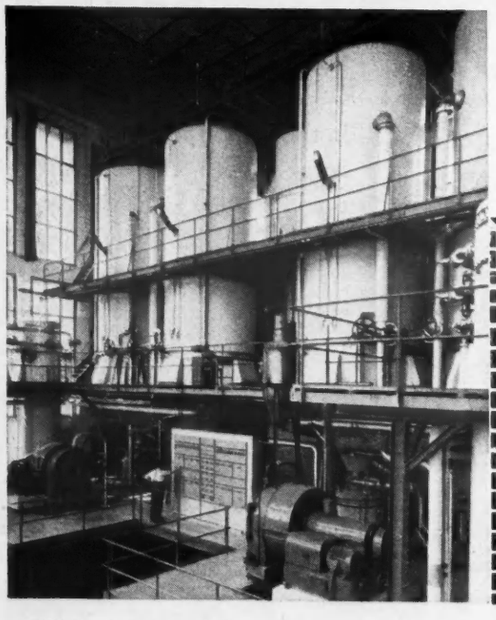

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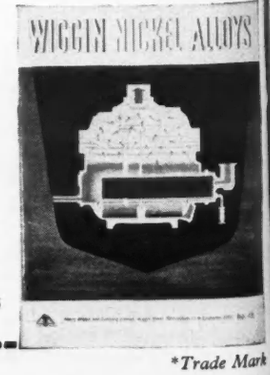

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If you are only interested in certain items mentioned in an advertisement would you please indicate which these are in the space provided.

Cards posted from abroad require a stamp

THE ENGINEER READER INFORMATION SERVICE

Please arrange for me to receive further details about the products, the reference number(s) of which I have entered below:— *References apply to issue dated June, 17 1960*

No..... No..... No..... No.....

No..... No..... No..... No.....

ITEMS .....

BLOCK LETTERS PLEASE

NAME .....

POSITION HELD .....

NATURE OF BUSINESS .....

NAME OF FIRM .....

ADDRESS .....

.....

.....

1 *Do you wish a representative from any of the above firms to call now?*.....

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6 *Do you wish a representative from any of the above firms to call now?*.....

KEMPE'S Engineers Year-Book

1960 (65th Edition)

A complete library in TWO VOLUMES. 3,000 pages, 79 chapters, 17,000 index entries covering modern theory and practice in all branches of engineering

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PILED FOUNDATIONS

WE UNDERTAKE PILING AND FOUNDATION. WE WILL INCLUDE DESIGN IF REQUIRED BROCHURE AVAILABLE ON REQUEST.

HOLST & CO LTD
Civil Engineering Contractors, Reinforced Concrete

Head Office:
46 CLARENDON ROAD, WATFORD, HERTS.
Telephone: Watford 34481

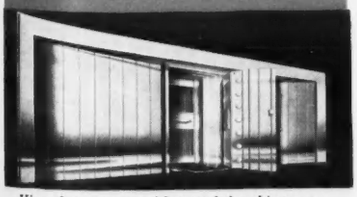
BRANCHES : BIRMINGHAM · MANCHESTER · LEEDS · DURHAM · EDINBURGH · CARDIFF.

Enter No. C51 on reply card

At the push of a finger

The door, foremost in design and craftsmanship, incorporates the most up to date locking devices and affords a very great measure of protection. But once the multiple locks have been disengaged a child of six can swing the massive doors. Hinged on Hoffmann Bearings, a mere 6 lbs. pressure moves them.
Chubbs sought utmost reliability, utmost freedom of movement, utmost strength: they put their trust in Hoffmann Bearings.

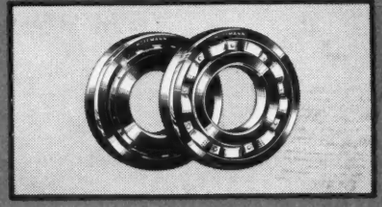
At the push of a finger this massive strongroom door swings safely into position—a pressure of 6 lbs. moves 33 tons, the weight of the door.



View of strongroom with extended architrave as it will appear when installed.

A CHUBB ACHIEVEMENT HINGED UPON . . .

HOFFMANN Bearings



THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

Enter No. C52 on reply card

What makes *this* diesel crane better than others...

FEATURES LIKE THESE!

FAST, CONTINUOUS OPERATION
Takes less time. Hoists 5-ton load *on single line* at high speed.

ABSOLUTE PRECISION LOAD-LOWERING
New power-lowering feature provides creeping speeds for accurate placing of loads.

NONE TO COMPARE FOR GRABBING DUTIES
Sound construction and equipment, including Smith's automatic double-barrel (operated by single control), gives incomparable grab service. For single line grab duties, normal barrel is used.

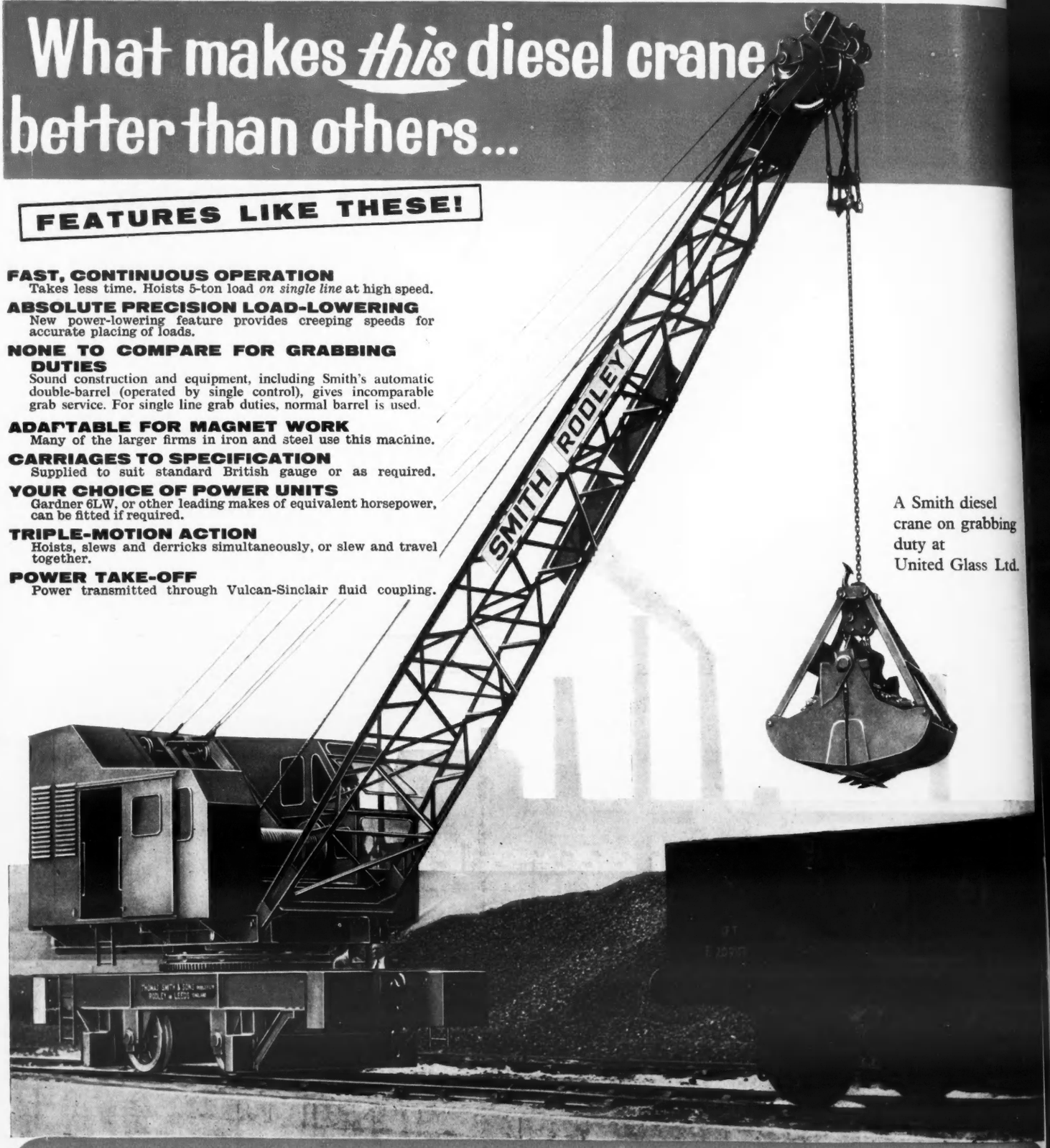
ADAPTABLE FOR MAGNET WORK
Many of the larger firms in iron and steel use this machine.

CARRIAGES TO SPECIFICATION
Supplied to suit standard British gauge or as required.

YOUR CHOICE OF POWER UNITS
Gardner 6LW, or other leading makes of equivalent horsepower, can be fitted if required.

TRIPLE-MOTION ACTION
Hoists, slews and derricks simultaneously, or slew and travel together.

POWER TAKE-OFF
Power transmitted through Vulcan-Sinclair fluid coupling.



A Smith diesel crane on grabbing duty at United Glass Ltd.

This is the Smith standard diesel crane which is ideally suited to solve the handling problems of so many industries – engineering, iron and steel, paper mills, public works, railways, coal and coke depots, waterways, etc. Let us have your enquiry – check on these features.

THOMAS SMITH & SONS (RODLEY) LTD

SMITH

RODLEY · LEEDS · ENGLAND

Enter No. C6 on reply c